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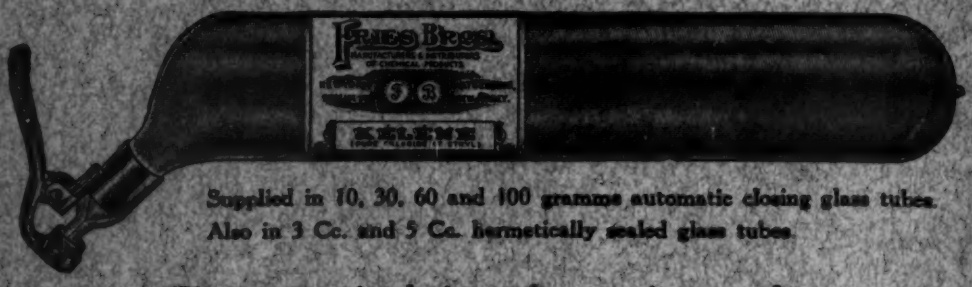

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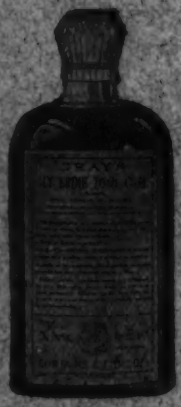

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ANNALS *of* SURGERY

VOL. LXXXIX FEBRUARY, 1929 No. 2

THE FUTURE OF SURGERY*

BY WALTON MARTIN, M.D.

OF NEW YORK, N. Y.

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WHEN "The Future of Surgery" was suggested to me as a subject I set about thinking of the various methods used in prophesying. I thought of the forecasts of the Weather Bureau, the exact predictions of astronomers, the extravagant prophecies made haphazard by story tellers, often curiously accurate, and the cautious guesses regarding future happenings made by the students of the past, suggestions of possibilities rather than predictions. It seemed to me that one might arrange the methods in three groups: the scientific, the romantic and the historical.

Knowledge gained by observation, arranged systematically, the painstaking study of the relations of these observations, the setting down, to be remembered, coexistences and repeated like sequences, belong to the scientific method. Making hypotheses which fit the succession of happenings, the testing of these hypotheses so as to establish them as theories and the appreciation of the rightness of these theories by their yielding confident forecasts, practical experience proving them to be sound time after time, also form part of the scientific method. A chemical reaction, the occurrence of an eclipse, are examples of prophecies fulfilled. For prophecy is a legitimate outcome of the scientific method. It implies an accurate knowledge of all the conditions and a narrow field of investigation.

In the second method, which, for want of a better name, I have called the romantic because it is not infrequently found in tales in which the incidents are remote from every-day life and experience, the prediction is but part of the fiction. If by chance there is any faintly similar occurrence years afterward, the story is looked on as prophetic. Such are the tales of Jules Verne: "Forty Thousand Leagues Under the Sea" or "Round the World in Eighty Days" or the journey to France by airship of Mr. Ponderevo in "Tono-Bungay" by H. G. Wells.

At times, however, unhampered by a story, prophecies are thrown out in pure exuberance of fancy. If the writer is trained in a branch of science and the imaginings are confined to his special field of inquiry, the prophecies are always interesting and stimulating. They seem most real, however, I

* Address delivered before The Academy of Medicine, New York, May 3, 1928.

think, to those least familiar with the particular branch of knowledge in which the writer is a specialist, for knowledge breeds scepticism, inculcates caution, makes one conscious of the difficulties of accomplishment. A forecast of Mr. I. B. S. Haldane, a reader in biochemistry in Cambridge University, is pertinent. In an essay called "Daedalus, or Science and the Future", read in 1923, after referring to an extraordinarily accurate prediction on the use of airplanes in warfare made by H. G. Wells in a book called "Anticipations", he goes on to say: "I propose in this paper to make no prophecies rasher". He then predicts the production of ectogenic children, one hundred years from now. I cannot refrain from quoting from the paper on the influence of biology on history, supposed to be written by a rather stupid undergraduate during his first term in the year 2073: "Dupont and Schwartz obtained a fresh ovary from a woman who was the victim of an aeroplane accident, and kept it living in their medium for five years. They obtained several eggs from it and fertilized them successfully, but the problem of the nutrition and support of the embryo was more difficult and was only solved in the fourth year. Now that the technic is fully developed we can take an ovary from a woman and keep it growing in a suitable fluid for as long as twenty years, producing a fresh ovum each month, of which 90 per cent. can be fertilized and the embryos grown successfully for nine months, and then brought out into the air. Schwartz never got such good results, but the news of his first success caused an unprecedented sensation throughout the entire world, for the birthrate was already less than the deathrate in most civilized countries. France was the first country to adopt ectogenesis officially, and by 1968 was producing 60,000 children annually by this method." I know of no better example of the romantic method.

The last way, the historical, does not attempt prophecy. It studies the records, the papers and the succession of text-books and attempts to make out the gradual unfolding of any branch of knowledge or any art. It investigates the past and works out from it the trend of the present; it makes no bold speculative inductions, the sketch of coming time is roughly indicated, not sharply drawn. This method seems to me best suited for the study of the future of the art of surgery. I shall begin, therefore, with a retrospect of surgery. I shall attempt to find suggestions of the future by looking back on the records of the past.

In the first chapter of the tenth edition of "The Science and Art of Surgery" by Sir John Eric Erichsen, written in 1895, it is pointed out that there cannot always be fresh fields for conquest by the knife, there must be portions of the human frame that will ever remain sacred from the hands of the surgeon. "When we reflect", he writes, "that every large artery in the body up to the aorta itself has been ligated, that each of the six large articulations and many of the bones have been resected, that amputation at the shoulder or hip is a matter of ordinary occurrence, that tumors have been excised from every region of the body, that the larynx, the spleen, the kidney,

the pregnant uterus and even portions of the liver, stomach and brain have been successfully removed, we can scarcely doubt that the limits of surgery have been nearly reached."

"But if", he goes on to say, "the mechanical Art of Surgery has attained to so high a degree of perfection that we can scarcely hope for much further progress in that direction, the case is widely different with the Science. Here truly, so far from having approached the limits of our subject, we are but as yet on the threshold. For whether we regard the Science of Surgery in its relation to the essential nature, the pathology and the diagnosis of surgical disease and injuries, or whether we consider it in reference to all those circumstances which, independently of the mechanical skill of the operator, influence for good or for ill the results of his procedures, we have a field before us the extent of which it is difficult yet to estimate."

The first part of this prediction has been often quoted in papers on the "Future of Surgery" to show how wrong Erichsen was. Yet I venture to quote it in its entirety as essentially correct for the thirty-three years that have passed since it was written. The third of a century, or a generation, about the time that I have been able personally to follow the development of surgery (the ninth edition was one of the text-books I used when a student in medicine) has again shown that the advance of science has produced the advance in surgery. Erichsen's qualifications for making such a statement on surgery were unusual. The first edition of his book appeared in 1853. He writes that it represents the substance of lectures on surgery delivered at University College since his appointment to the Chair of Surgery in that institution. He was appointed in 1850 and Lister was his house surgeon the following year. On December 22, 1846, he had been present at the first public operations on patients anæsthetized by ether. Lister saw the same operation as a first year student. By the time the eighth edition appeared, thirty-one years later, in 1884, he could write of the antiseptic methods introduced by Lister and "founded on the experimental researches of Pasteur." He was writing and teaching surgery when two of the discoveries that have most influenced it took place.

Erichsen distinguished sharply between the art and the science of surgery. I think this has led to some misunderstanding. Neither the past of surgery nor the future can be discussed without an attempt to make clear the relation of allied sciences to surgery and to discuss whether one can even speak properly of the science of surgery. During the forty years that the various editions of his book were used as a text-book in England and America, it was published under the title of "The Art and Science of Surgery". He had always in mind that there was something more in surgery than manual dexterity. He writes: "a great surgical operation, in its conception, performance and its completion, tests the operator's medical knowledge as much as and in as varied a manner as it taxes his manual skill." By the Science of Surgery he evidently meant what he rightly refers to in this sentence as medical knowledge, the notions of the etiology, exact notions not only of the

morbid anatomy and the morbid physiology of the condition but of the patient he is treating. Surgery, if you will, is an applied science. Erichsen, himself, in one place calls it a scientific art, but for most of us it is essentially a practice, a way of treating disease. When Iago asks Cassio if he is hurt and Cassio replies: "Aye, past all surgery," he is thinking, not of any systematized knowledge, but that he is so badly injured that he cannot be repaired, he is broken past mending, even if it is only his reputation he is thinking of. Since Shakespeare's time it has always been used in this sense. In the large Oxford dictionary the only definition of surgery is "the art or practice of treating injuries, deformities and disease by manual measures." To be sure there is an element of science in every art. But have we not all a vague understanding that science has to do with knowing and art with doing?

The surgeon, if you will, is an artisan, a handicraftman. His handicraft is influenced largely by classified and systematized knowledge, verified by repeated clinical observations and checked by research and experiment in a variety of closely allied subjects, but outside this he is dealing with things incomplete and uncertain, things he learns only by experience. He belongs in a group with the farmer, the carpenter, the builder and the navigator.

One skilled in guiding vessels over the seas into distant harbors determines his ship's position by geometry and nautical astronomy, but seamanship is necessary. He must have an eye to tides and variable winds, floating icebergs and shifting sandbars. Thus it is with the surgeon: he must practice his art under changing circumstances and in conditioning environments often imperfectly understood. The various sciences he uses are shared with the medical practitioner, just as the navigator shares applied geometry with the surveyor and the builder. It seems to me, in studying surgery in the past or in attempting to determine its trends in the present, it is a mistake to divide it into an art and a science. It is clearer to think of it as a practice and to speak of the technic and the fields with which it is occupied. Surgery is concerned with a group of disorders which the state of medical knowledge at any given time, believes to be most advantageously treated by manual measures.

I shall therefore consider the technic of surgery and the field of surgery, and attempt to show how they have been modified since Erichsen's time and how we may expect them to be modified with the understanding that the two go hand in hand.

Every art has a technic, a mode of execution, a special skill in working out the desired end and this special skill is dependent largely on the congenital aptitude for the work in hand, on apprenticeship and on opportunity.

Each one of us is born with slight differences in makeup, our natural propensity varies our ability to do things. A man is born with a hand that does things easily and skillfully, just as he may be born with an ear and a brain that can distinguish fractional differences in wave lengths of sound, and a man may come into the world with unusually delicate muscular sense, that sense which registers in the brain the stress or strain which is being

exerted. There are wide variations in visual memory. If two boys without training are set down before a clock and asked to take it down and set it up, one may do it far more readily than the other. Both will probably easily take it apart, but one has seen in his mind's eye so accurately the relation of each part as it was taken down that he can put it together again without difficulty. The faculty of acting well under unexpected circumstances, a certain coolness and absence of flutter and agitation when acting in an emergency, seems to be more marked in some children than in others. A certain rapid and accurate appreciation of the relative value and probable sequence of things, an intellectual grasp of the group of all the attendant circumstances, what we call sagacity or mother wit, is far more marked in some than in others and seems altogether independent of cleverness in books and a facility in solving set problems.

Deftness, muscular sense, eye memory, self-possession, presence of mind and common sense, are all qualities especially valuable to the surgeon.

We are concerned with whether or not they are all to be more marked in the future and whether, as we look back, we find any evidence that these qualities were less developed. The whole trend of modern teaching points in one direction. Paleontologists, anthropologists and historians give one answer. They all show that biological development has nearly stopped or is too slow to be appreciated in the historical period. Looking back on the long stretches of time since man first began to make tools, makes us realize that Hippocrates and Galen are our contemporaries. We have not the slightest reason for thinking that children born today or that will be born tomorrow are defter, better natural workmen than those in Athens five hundred years before Christ, or the goldsmiths, architects, sculptors, painters, workers in stone and carvers of wood living in Florence in the fifteenth century.

Aside from inborn fitness for any art or craft, there is the question of training and opportunity. The natural variations in the characteristics we have enumerated give us such a wide range in the combination of qualities that the average man is within the range of a skilled worker, provided he serves an apprenticeship and provided occasion is given for the carrying out of his craft. One might make a rough guess that 5 per cent. of the house surgeons that one remembers were congenitally unfit for the task and that 5 per cent. have shown such an unusual natural endowment that, with practice and opportunity, they were generally recognized as destined to be outstanding figures, but that 90 per cent. have sufficient natural capacity to become competent surgeons with the training and the chance. The ordinary builder, plumber, carpenter, and painter that one sees is good at his trade, not because he is exceptionally gifted, but because he is exceptionally trained and has unusual opportunity to work at his trade. As Emerson said in his essay on "Power", practice is nine-tenths. Initiatory training, the setting to work assisting and carrying out under direction gradually more and more difficult tasks, doing over and over again the various technical procedures till they sink into the subconscious and become reflexes, and an opportunity to work

day after day, are indispensable in the attainment of skill in any of the arts and crafts. If we have little reason to believe in a change in natural capacity, we have convincing proof that there has been a gradual increase, both in the opportunity to do surgery and in the opportunity to learn its art as an apprentice. The most casual glance at hospital records shows an extraordinary increase in the number of operations during the last thirty-three years. The costly and elaborate technic necessary in modern surgery is gradually throwing all surgical work into hospitals and clinics. More and more, the surgeon will operate where he does it to the greatest advantage. The ease of communication, the drift of the populations toward large centres, are tending and will continue to tend to take the sick to the surgeon rather than the surgeon to the sick. This tendency has acted and will act to give not only increasing opportunity to do surgery but to learn surgery. There is every reason to suppose that surgery, throughout the world, will surely and slowly advance technically. The widespread and growing disposition of groups of workers, from different parts of the same country and from far off countries, to watch surgical procedures, not in amphitheatres as formerly, but over the shoulder of the operator, makes for uniformity. The surgeon of the out-of-the-way places (and the time seems approaching when there will be no out-of-the-way places), sees and copies the work done in the great clinics and centres of surgical activities. In the future one would expect not so much a development of a few with extraordinary facility, but a great increase in the number of those who are considered highly skilled.

By 1895, the introduction of anæsthesia and the knowledge of the relation of microörganisms to wound infection had made surgery relatively painless and relatively safe. The knowledge of anatomy had advanced to a stage when the naked eye appearance of the various structures and organs had been accurately described and correctly represented. The various operative procedures worked out on the cadaver for the ligation of vessels, amputations and disarticulations, are described accurately in *Faraboeuf's Manual,* published in 1895. The completion of this Operative Surgery by the prosectors of Paris, published in 1904, including operations on the various organs, gives a description of most of the procedures in use today. Forty-two years ago Billroth reported fourteen cases of the excision of the pylorus and modifications of these procedures are still used. The open treatment for fractures and the introduction of plates for holding the fragments was discussed and warmly advocated in the Ninth Congress of Surgeons, in Paris, in 1895. Twenty-eight years ago a report from Krönlein's Clinic in Zurich on the end results of operative treatment of twenty cases of exophthalmic goitre, including ligation of the vessels, resection and enucleation, was published. The patients had been operated on between the years 1888 and 1900. In 1895, Ssabanejew performed the first embolectomy, removing an embolus from the femoral artery. By 1910, portions of the hypophysis had been removed fourteen times. All these reports, however, show a far higher mortality than at present. The thyroidectomies showed a mortality of 8.6 per cent. The

mortality in nephrectomy for tuberculosis was over 30 per cent.; today it is 2 per cent. Billroth reported eight deaths and six recoveries in pylorectomy; three years ago Balfour reported forty-six partial gastrectomies with one death. We could go on multiplying examples.

The advance has not been in new procedures but in perfecting old procedures, in refinement of technic and in lessened mortality. With a gradual increase in the number of patients, with increased opportunity to perform operations, there has developed increased skill and, with increased skill, lessened mortality. With lessened mortality more patients have come to the surgeon. A favorable circle has been created during the last thirty years.

Another factor, aside from relative safety and relative painlessness, that has brought about the increase in surgery, is increased accuracy in diagnosis. The surgeon is essentially concerned with what he can see and feel. The visible field has been largely increased, especially since 1895. In days when there was uncertainty whether or not a stone that was supposed to be causing symptoms would be found, it was but natural that there should be reluctance to submit to attempts to remove it. Three hundred and fifty years ago, Montaigne was complaining that "a gentleman in Paris was not long since cut for the stone, in whose bladder they found no more stone than in his hand."

Toward the end of 1895 the discovery of a physicist, Röntgen, and the developments arising from this discovery, introduced into medicine a most valuable diagnostic method.

In 1879, Edison invented a lamp with a carbonized thread for a filament, sealed in an airtight glass tube. Within a few years the cystoscope, the œsophagoscope, the proctoscope and the bronchoscope had come into use. The perfection of these and similar instruments since 1895, again offers an increased field of exact observation. Accuracy in diagnosis has contributed largely to the confidence of the medical practitioner and the general public in surgical work, and modern surgery is built on this confidence.

One may say that surgical technic has now advanced to the point where any structure in the body can be exposed, inspected and manipulated. With the perfection of skill there has been a perfection of instruments, appliances and media. The science of chemistry will undoubtedly furnish better local anæsthetics and antiseptics. It seems highly probable that among the endless synthetic compounds one will be found less poisonous and more powerful than any that we now possess. The trend as recorded seems to indicate lessened risk from infection and lessened risk from induced anæsthesia and, with the latter, a distinct increase in the use of local and regional anæsthesia. As the limit of absolute safety is approached a slower and slower advance is to be expected.

The field of surgery presents a different and à most interesting problem. It has changed and will certainly change. The disorders turned over to the surgeon from the earliest times have been injuries, congenital malformations, acquired deformities, foreign bodies and concretions, certain phases of the

defense reaction of the body to infection, and the removal of tumors. There has been added in recent years an effort to control and regulate function by mechanical means.

One may say with reasonable assurance that congenital malformations, hernias, cleft palates, pilonidal cysts and branchiogenic cysts and sinuses, congenital pyloric stenoses, Meckel's diverticulum, patent urachus, exstrophy of the bladder, etc., will come to the surgeon as they have in the past for rectification and repair. Each year, for reasons we have already referred to, more of these deformities will be turned over to the surgeon.

It is interesting to speculate on the number of injuries in the modern world, in the world of the past and the world of the future. Were more men kicked by horses, thrown or run away with than are smashed by motor cars, hurt in railway accidents and disabled by modern machinery? Will the wider use of the airplane, with diminished hazard of collision and added hazard of falling, increase or decrease the number injured? One can only make passing observations. In a country with prohibition in the constitution, in one small park in a large city, two lamp posts a week are destroyed by motor cars in head-on collisions. I believe injuries in proportion to the population are increasing, not decreasing; that the curious tendency to crowd closer and closer together in urban centres and to use more powerful and swifter moving machines is accompanied by largely increased risk of injuries. The surgeon of the future will have more, not fewer injuries to treat.

Is warfare to be more or less destructive? The perfection of guns, projectiles and explosive substances seems to suggest but one answer. In Captain B. H. Liddell Hart's little book on "The Future of War", he points out that, by a curious combination of sentimental pacifists and traditional militarists, the most merciful weapon yet devised has been outlawed, namely, poison gas. "Even with the lethal gases of the last war, the use of which was decried as barbarous by conventional sentimentalists, statistics show that the proportion of deaths to the number temporarily incapacitated was far less than with the accepted weapons, such as bullets and shells." He quotes the views of a high German authority, General von Altrock: "In wars of the future the initial hostile attacks will be . . . against its large cities, factory centres, munition areas, water, gas and light supplies. Discharge of poison gases will become the rule. Entire regions inhabited by peaceful populations will be continually threatened with extinction." Captain Hart's conclusion is that the weapon, the target and the aim will alike be civil. The work of the surgeon in war may be largely in the civil hospitals.

Foreign bodies and concretions in the ducts of glands fall to the surgeon. Is the time coming when a knowledge of the chemistry of secretions will be sufficient to prevent the formation of calculi, or will a synthetic drug be discovered with solvent action on the constituents of stones? It is possible, but the factors entering into their formation are so complex, the part played by infection and even possibly by the congenital peculiarities which tend to produce stasis is so imperfectly understood that it is conjectural if, for years,

there will be a better means at our disposal than to remove them when they have once formed.

The surgeon, from the earliest times, has opened abscesses and removed infected foreign bodies and necrotic tissue. He learned empirically, at least two thousand years ago, the efficacy of these measures. The better understanding of the nature of infection led for a time to the radical removal of all centres of infection. There was a period when primary chancres were cut out, anthrax pustules widely removed, secondarily infected glands excised and incisions made in erysipelas. If pyogenic infection progressed it was assumed that the cuts were not long enough or deep enough. The trend of opinion in recent years, guided by more exact knowledge of the sequence of events that follow one another when microörganisms are introduced into the body, has modified these practices. It is generally recognized that anthrax does better with the introduction of serum, without excision, than with excision. We now know that during the period of first incubation, between the contaminating contact and the appearance of the primary lesion, the spirochætæ have passed into the lymphatics. The future will elucidate still further all these questions. There may be less, rather than more, surgery in this particular field. With more exact understanding of the way accidental inoculation takes place, the various infections should decrease. Tuberculosis is apparently decreasing. Should it be eliminated or brought under control, as it may well be, a large field of surgical practice would be removed. Syphilis, in some countries at least, is on the increase, but the severer forms leading to ulcerative and disfiguring deformities that came so often into the hands of the surgeons of the past seem to be decreasing, due to early recognition and prompter treatment and probably also to more resistance on the part of the subject or an attenuated virus. The philosopher, Doctor Panglos, in 1798, lost an eye and most of his nose before he was cured. I recommend the perusal of the genealogy of his infection in Voltaire's "Candide".

The introduction of chemotherapy by Ehrlich, with a direct attack on the causative agent, brings up the interesting question of the possibility of a sterilisans magna which, injected directly into the blood, will destroy microparasites. Among the endless synthetic compounds will one be found that interferes with the life and nutrition of the minute vegetable cells and yet does not interfere with the life, nutrition and function of the far more delicate animal cells? It is evident that, one by one, the animal parasites are being brought under control by chemical substances. The toxic effect of antimony on the ova of bilharzia is a recent and conspicuous example. There is little evidence as yet of such control in the group of bacteria.

The doctrine of focal infections advanced in the last ten years has had a tendency to increase the number of operations. There has grown up a widespread belief in the efficacy of the removal of the teeth, tonsils, gall-bladders, appendices, etc., in many instances showing such slightly morbid changes that they are within the range of similar structures which it has been proved over

and over again most of us are carrying about without conscious detriment to our well being. I believe this tendency will increase. The impulse comes from the reports of striking improvement in a variety of chronic ailments, such as arthritis, neuralgia, headache, lassitude, world weariness, etc., which I assume may even become more frequent in the future.

Surgeons have excised tumors for years. With more exact notions of the course of malignant neoplasms and a more careful study of the characteristics of the different types, it has become evident that in a considerable number of cases the results have been disappointing. The systematic effort to follow patients that have been operated on, year after year, has brought knowledge of late recurrences. The curious observation that even the wide removal of small neoplasms has not always resulted in curing the patient, and the converse, that patients have remained well for years after the excision of extensive neoplasms fairly close to the growth, have both been disconcerting.

There has grown up at the same time a knowledge of the destructive and inhibiting effect of X-rays either emitted by the X-ray tube or by radium. Growths in certain regions have passed out of the domain of operative surgery. In carcinoma of the cervix, for example, radium has come to be the method of choice. It is recognized today that both surgery and the X-ray have a place; that the best we can do for cancer is still to excise it widely; but that frequently an operation must be considered palliative and supplemented by other methods. These changes in the attitude of the surgeon toward neoplasms have all been admirably reviewed in a recent paper by Prof. F. C. Wood.

The knowledge that cancer develops most frequently in areas of chronic ulceration and in slightly damaged tissue has introduced the conception of a pre-cancerous stage. A widespread belief has grown up that all areas that have been subject to chronic irritation, all chronic ulcerations, moles, warts, senile keratoses, healed lacerations, etc., should be removed. This is increasing the field of surgery at present and probably will do so even more in the immediate future.

What will the future show? A few days ago I told one of my friends who has specialized in the subject of malignancy and whose acumen, experience and sceptical attitude are widely known, that I was going to suggest as a possibility that within a hundred years the etiology of malignant neoplasms would be known. He replied: "It is possible within a thousand years." I made bold to suggest, however, that within fifty years we may know enough to completely change surgical practice and to remove certain at least of the new growths altogether from the field of surgery and that we shall look back on our present efforts as extraordinarily crude. I admit today that the student of malignancy is bound to feel as Harvey felt when he first watched the beating of the tumultuous heart and attempted to make out the sequence of happenings. He wrote, you remember: "When I first gave my mind to vivisections, as a means of discovering the motions and uses of

the heart, and sought to discover these from actual inspection and not from the writings of others, I found the task so truly arduous, so full of difficulties, that I was tempted to think, with Fracastorius, that the motion of the heart was only to be comprehended by God." But the circulation was discovered and the movements of the heart made clear, notwithstanding Fracastorius, and all seems simple today.

One may say that thirty years ago a surgeon was concerned with the anatomical consideration of whether he could remove a given tumor. Today, having mastered the technical difficulties, he is confronted with the question as to how much he accomplishes with a given mutilation and as to when a given area of chronic irritation is to be considered a precursor of cancer.

The control of abnormal function, when accompanied by obvious hypertrophy of a gland, has furnished conspicuous successes in the surgery of the spleen and partial successes in the surgery of the thyroid. The extirpation, excision and division of nerves has, for years, been a recognized measure in treating intolerable neuralgias. Recently there has been tendency, guided by these experiences, to extend the field. The suprarenal of normal size and appearance, for example, has been partially excised for epilepsy, neurasthenia and in conjunction with the thyroid for exophthalmic goitre. It has been partially removed in a number of instances for gangrene due to endarteritis and Raynaud's disease.

Twenty-two years ago Jonnesco reported a series of 159 cases in which he had removed the cervical sympathetic ganglia and chain. Twenty-five of these were in exophthalmic goitre and were reported as complete successes, every symptom disappearing. Recently a number of operations have been introduced on other portions of the involuntary nervous system to control spasm or supposed spasm or to cause dilatation. Portions of the autonomic system that supply the pylorus have been excised to relieve pyloric spasm; the perivascular sympathetic fibres have been removed to cure various conditions such as chronic ulceration, gangrene, causalgia, Raynaud's disease, etc. Peripheral facial paralysis has been treated by removing the superior cervical sympathetic ganglion. The lumbar sympathetic ganglia have been removed to relieve congenital megacolon. It is unnecessary to multiply examples. New operations are appearing and will continue to appear in this field.

Surgery seems to be changing from a science largely concerned with normal anatomy and palpable and visible morbid anatomy to one especially concerned with normal and morbid physiology. Disturbances of function were, in the past, only considered when obviously connected with gross alteration in structure. The surgery of yesterday was dominated by anatomy, the surgery of today is dominated by physiology and the surgery of tomorrow will be more so.

Which of these newer procedures will survive and take a permanent place in surgery? One can only say that few, so far, have gained any widespread recognition. They have been introduced for the most part as being successful

in practice, the reason of the efficacy of the procedure being unknown. The proof of their virtue is founded on the reports of a few cases in which improvement occurred and which, in the early reports, is nearly always described as "truly astonishing". The value of many of these procedures may be in the stimulus given to exact study to affirm or refute the theory propounded and the results reported. Unfortunately medical history is filled with similar reports of extraordinary cures resulting from all sorts of drugs and chemicals and all manner of procedures. I recommend anyone who is interested in the subject to look up the different measures which have cured or benefited either epilepsy or erysipelas.

The surgeon of the past read and studied anatomy and then worked out his operation on the cadaver. I believe the surgeon of the future will read and study physiology as he studied anatomy in the past and as he worked out the technic of his operation from the anatomical standpoint, so in the future, he will think of the purpose of his operation after careful consideration of the experimental facts already given in the text-books of physiology.

Will the future show not only an effort to control function by excision but by transplantation? Will a technic be perfected which will make transplantation as frequent as partial excision? Will failing function in an organ like the kidney be restored by transplanting a sound kidney? I remember a discussion just after Carrel and Guthrie, twenty-two years ago, reported "The successful transplantation of both kidneys from a dog into a bitch with the removal of both normal kidneys from the latter," in which such a prediction was made. It seemed to me at the time unlikely. Are Voronoff and Steinach correct and will the surgery of the future record thousands of operations transplanting monkey glands and cutting off the vas deferens? As exact knowledge accumulates it seems to me that the trend will be toward diminishing rather than increasing surgical practice in all these fields. With an exact knowledge of the so-called endocrine balance, with the introduction of artificial chemical imitations of the various hormones, with the possibility of exact knowledge of the cause of the insufficiency or overactivity, may we not look back even on the effort to control an over-acting thyroid by cutting portions of it away, without the slightest knowledge of the agents that have incited it to increased activity, as but an improvised measure?

It seems to me less fanciful to imagine a knowledge sufficient to enable a recognition of the causes of chronic changes in the kidneys, and their avoidance, than to imagine the social rearrangements necessary to obtain sound human kidneys and the difficulties in technic necessary to keep a highly specialized organ like the kidney alive outside the body for any length of time. Notwithstanding the vigor and lust of the goat described by Voronoff, after testicular grafting, my imagination finds it simpler to see a possible return to a perfection of the method of Brown-Séquard. Old men may take, each morning, a potent chemical product, the exact imitation of a testicular hormone, and have the delusions of youth return. Old men, that is, who have

not the wisdom of Cephalus, that delightful old man recorded in Plato's "Republic" who, when asked what report he gave of old age, quoted a saying of the aged Sophocles who, in reply to a similar question said: "Peace, I feel as if I had escaped from a mad and furious master."

One of the most brilliant and best known surgeons of France, Leriche, in his address on taking the Chair of Surgery in Strassburg, delivered in 1925, spoke on the future of surgery. I wish to call your attention to the views expressed. "Surgery" he said, "has become one of the most important branches of physiology and if its supreme aim is therapeutic it has equally as an aim the knowledge of the healthy man and the sick man and should be considered as one of the normal procedures in the study of biology. Surgery has arrived at the end of a period largely clinical and technical. It has taken forty years to arrive at this mastery. During this short period it has accomplished a considerable work; it has acquired an admirable sureness in its acts; it has created its methods, studied the morbid physiology of some disorders, fixed the nature, the pathological anatomy and the evolution of a great number of diseases; it has prepared the balance sheet of its possibilities and called in its long term notes. Now, proud but not satisfied, it is at its apogee."

Leriche depicts the future. He sets before the mind's eye his conception of an operation on the heart, accomplished not by dividing a stenosed valve, which may readily heal again, as has been done, but "under certain conditions of cardiac arythmia rebellious to medication, the cutting of some small branch at the base of the neck, the suppression of which will diminish the excitability of the musculature of the auricle." He goes on to say that to many minds, to all appearances excellent but in reality commonplace, there is a divorce between the practice of surgery and these scientific aims.

I beg to place myself among these ordinary minds. I think a surgeon should read, mark and inwardly digest all that he can of physiology, pathology and bacteriology; that he should observe accurately and record with a scrupulous exactness, all that comes in his way in his unrivaled opportunity to see and study normal and abnormal function and structure; that he should be scientifically minded and scientifically educated and should heartily dislike unchecked reports and unverified theories. He should recognize that proof lies not in a few observations made shortly after a given procedure. He should be aware of the multitude of interfering conditions and remember that the experimental method is part of scientific verification. But he should know that his aim is solely curative and that all the rest is incidental. He gains his livelihood by his procedures and is under scrupulous obligation in this regard. Otherwise he should narrow his fields of observation and become an experimental physiologist, and he should have a scientific recognition of the difference between an experimental physiologist and a surgeon. I will give an example. I read in a physiology recently published, in an article on "Coagulation" the following statement: "Surgeons have frequently noticed

that total hysterectomy is less grave than subtotal. In the latter case, at times, one sees death from embolism. It seems as if the surface of the divided uterine muscle exerted an action favorable for thrombosis." How many observations led to this conclusion? How careful were the observations made on the source of the primary thrombus? Is this a scientific statement and was the surgeon, as a physiologist, contributing a verified fact?

All has a bearing on the future of surgery. Is surgery about to enter on an experimental phase; is it about to abandon the sure footing which has kept it free from much of the jargon of the medical practitioner? It seems to me unlikely. It seems far more probable that the future will show surgery guided largely by common sense as it has been in the past, with an instinctive distrust of all that cannot be demonstrated by a large body of results. The practical mind of the surgeon will again perhaps be rather too incredulous rather than too credulous of new procedures and ideas.

All great advances so far have come from the allied sciences. We owe even the anæsthetics nitrous oxide, ether and chloroform to the English chemist Davy, to another English chemist and physicist Faraday and the French scientist, Flourens, although we associate their practical introduction with the names of two American dentists and a Scottish physician. A professor of chemistry, Pasteur, made the great induction that microparasites caused infection. Röntgen, a pure physicist, introduced the X-ray. Has science nothing more to offer? I feel certain it has.

We may, to be sure, be starting on a phase when advance, for a long time, will be hardly perceptible, as in the period between Galen and Vesalius. We may have reached the limit of modern technical methods. The microscope and the methods of staining tissues may reveal nothing further. Physiology and physics may become more and more esoteric, given over to formulæ and curves intelligible only to the initiated. I do not believe it. If you look at the past there has been this extraordinary elucidation of one thing after another going on, teaching nothing of the ultimate meaning of things, increasing, not diminishing the mystery, but leading us by definite and logical action to avoid and produce certain sequences. Knowledge is cumulative and the successive additions seem to be coming faster and faster.

That the surgeon of the future will have far more exact knowledge of things pertaining to his art to aid him, I cannot question. That medical science may take much out of the field of surgery that we think of today as permanently there, seems to me likely and that it may bring certain disorders incidental to new conditions into its sphere seems probable.

But the new knowledge will but increase the difficulty of understanding the ultimate causes of things. As Maeterlinck says somewhere, I think in the "Life of the Bee": "The purpose of knowledge is to increase our fields of conscious ignorance." Matter was comfortably defined when I was in college as anything that occupies space or as that which we can perceive by our sense of touch. Today the material world is uneasily poised on immaterial atoms.

I give a recent definition of matter: "Matter is but the sequence of events in experience and nature." We may even be about to find out and bridge over the bond between the physico-chemical on the one hand and the vital on the other. Therefore the comfort of working in one of the great handicrafts of today and tomorrow, one which deals with proximate and obvious causes, and aims at performing its manual acts so deftly and so gently that pain is relieved, deformities corrected, the normal workings of the body restored with trifling damage to the delicate living cells, and little disturbance to the organism as a whole.

Doctor Panglos, the great optimistic philosopher, said to Candide: "There is a concatenation of events in this best of all possible worlds." "All that is very well," answered Candide, "but let us cultivate our garden."

THE BIOLOGICAL EFFECTS OF THE X-RAY AND RADIUM AS AN AID IN THE DIAGNOSIS OF NEOPLASTIC DISEASES

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The study of the biological effects of the X-ray and radium has been related largely to their therapeutic value in neoplastic diseases, and a very considerable literature has been accumulated in regard to their clinical manifestations. Their mode of action also has been a subject of extensive discussion without yielding from the physicochemical standpoint any decisive conclusions. Within the domain of pathology, however, much valuable knowledge has been obtained from the observation of the morphological changes of the normal and tumor tissues which these agents produce. Added interest has been given recently to these changes by the efforts that are being made to grade the malignant qualities of tumors from their histological structure. So far it has been found possible by this method to foretell the radiation reaction with only a moderate degree of certainty. We have found, however, that the radiation reaction does indicate the histological type of tumor, and it is the purpose of this paper to show that the recognition of the radiation reactions, if combined with a careful review of the clinical setting, may afford much aid in the differential diagnosis of tumors.

As a result of the radiation treatment of tumors, the terms radio-sensitive and radio-resistant are becoming widely used as expressing the radiation reaction without giving them an accurate meaning, thereby causing confusion in regard to their applicability. It is generally recognized that certain tumors are very sensitive to the application of these agents without much relation to the dosage. For the present purpose, therefore, we would limit the term radio-sensitive to those tumors which show a prompt, rapid and easily appreciable regression after one application of either the X-ray or radium in a dosage insufficient to cause nutritional changes in the neighboring tissues. There may be differences in the degree of their response, but all tumors of this class show a specific reaction in that it is appreciably different from that of all other tumors to which we would apply the term radio-resistant. Among these, also, there are wide differences in their radiation reaction, but in none of them can the reaction be confused with that occurring in the class we have proposed to call radio-sensitive.

It is now known that tumors of the radio-sensitive type have a common histological structure without regard to their histogenesis. They may be sarcoma or carcinoma, but they are always very cellular with little or no supporting stroma. The cells are of the embryonal or anaplastic type; these tumors are very malignant, metastasize easily and are practically inoperable.

Moreover, this reaction may be regarded as specific in that all tumors of this type without regard to their size or location respond in the same way. A considerable number of tumors of this type are already recognized, so that by observing the comparative amount and rapidity of their regression an otherwise obscure tumor may be identified.

The observation of this reaction in metastases is especially valuable in differential diagnosis, for the general law of the preservation of the structural type is confirmed by the similarity of the reaction to that of the primary tumor. In accordance, therefore, with the tendency of metastases to show an increase of anaplasia, the radiation reaction is often more favorable in the metastases. We have occasionally observed, for example, radio-sensitiveness in lung metastases from radio-resistant bone tumors. The metastases, also, from teratoid tumors of the testicle almost uniformly show a more favorable reaction than the primary tumor, which, beginning as an anaplastic tumor and hence offering less room for an anaplastic increase, yet has metastases which become more simple because certain resistant elements of the primary tumor may be eliminated. A tumor of the neck, consisting of hard agglutinated nodes and appearing to be secondary to an epidermoid cancer of the mouth but without any such discoverable lesion, disappeared completely and rapidly after one application of radium. This reaction showed conclusively that it was not a squamous cancer, but was one belonging to the radio-sensitive type. A subsequent examination disclosed the absence of the left testicle, which had been removed three years previously but which the patient did not regard as sufficiently important to mention in his history. The diagnosis, therefore, was made of a metastasis from a taratoid tumor of the testicle, which was confirmed subsequently by a report from the surgeon who had removed the testicle. Our knowledge of the favorable radiation reaction of abdominal metastasis from this tumor shows convincingly how a therapeutic test with one or the other of these agents makes unnecessary an exploratory operation. The argument that occasionally no such response by testicular tumors occurs only indicates that all tumors of the testicle do not conform to the undifferentiated anaplastic type. Recently, the clinical features of a metastasis from a testicular tumor in a young boy, indicating that it was not of the teratoid type and that it would not respond to radiation in the way that teratoid tumors do, were confirmed by the slowness of the regression after radiation, and later by the microscopic section of the primary tumor, which showed it to be a spindle-cell sarcoma resembling somewhat a myosarcoma.

The desirability of using a therapeutic test in many situations is emphasized by the spectacular regressions that follow radiation of the Wilms' tumor of the kidney, which is so often the type existing in those bulky abdominal tumors in infants and young children. The frequency with which mediastinal tumors belong to the radio-sensitive type not only emphasizes the therapeutic value of radiation, but shows its value in either confirming a tentative clinical diagnosis or in rendering a diagnosis possible.

That the list of identified radio-sensitive tumors is not yet complete is

attested by the occasional results following the radiation of tumors in organs and tissues which are generally regarded as radio-resistant. The features of the bone tumor designated by Ewing as endothelial myeloma first attracted attention by the complete regression within three weeks after one external application of radium to a tumor of the radius, which had been regarded previously as an osteogenic sarcoma of the radio-resistant type. The death of the patient one year later permitted a study of the tumor, in which its peculiar cellular structure was disclosed and thus accounted for its regression after radium therapy. Other cases of bone tumor appeared with similar X-ray findings and histological structure, and all showing the same radio-sensitive quality, so that finally a characteristic clinical setting was revealed. No other bone tumor has shown the same radio-sensitive quality, except possibly the plasma-cell myeloma, which occasionally approaches it in its response.

More recently the radio-sensitiveness of the so-called transitional-cell carcinoma offers to the clinician an additional resource in the diagnosis of tumors, and to the radiologist a favorable field for radiation therapy. In the case of this tumor, also, the discovery of its uniform radio-sensitive qualities preceded the finding of a common histological structure. Cutler, at the Memorial Hospital, reviewing the records of cases of squamous cancer of the tongue and tonsil, found a group which showed radio-sensitive qualities, and which, after their microscopic sections had been reviewed, were found to have a common histological structure. Ewing had observed the atypical features of their structure, and in this review found that, although resembling the structure of an epidermoid cancer, the cells differed, being round, small, with a large hyperchromatic nucleus and little cytoplasm and without spine formation or hornification. After collating all of the clinical and pathological features, the entity of the tumor was established and its uniform radio-sensitiveness recognized. Our cases have most often been found at the base of the tongue or tonsil, beginning deeply and resulting in comparatively little and superficial ulceration, and making them often difficult to discover even after the formation of metastases, which appear early either in the regional nodes of the neck or in distant organs. According to our records, Cutler found transitional-cell carcinoma in 10 per cent. of the lesions at the base of the tongue and tonsil. They are practically inoperable because of their location and malignant qualities, but it is reasonable to expect that, if identified sufficiently early, a permanent cure by radiation may result. Our records show such tumors also to be located in the larynx, œsophagus, uterus and other organs. These tumors have opened up a wide field for discussion in regard to their histogenesis and exact nature. In Paris, under the term lymph-epithelioma, Regaud is presenting a tumor, the relation of which to the transitional-cell type is uncertain. To us their radio-sensitiveness makes them of special interest, explaining undoubtedly the occasional unexpected results of radiating tumors in regions in which usually no

such events occur. They, also in conjunction with the other tumors of the radio-sensitive type, may offer aid in the field of diagnosis.

A warning, however, must be made against the too wide application of the therapeutic test to tumors in all of the organs of the body. In the breast, for example, it is exceptional for a tumor to show radio-sensitive qualities, and it may therefore be unfair to the patient to delay operation in early and generally recognized operable cases. The tumor of the breast, designated as the inflammatory carcinoma, is usually highly radio-sensitive, is very malignant and a type in which operation has proved to be a failure. Such cases, however, have features by which they can be recognized clinically, thus rendering a therapeutic test unnecessary.

There are numerous factors which alter the normal radiation reaction of radio-sensitive tumors, which, if not recognized, may create a false impression of the value of the therapeutic test. A tumor in which its cellular structure is normally radio-sensitive, as those of the parotid or testicle, may not regress promptly because of the presence of certain radio-resistant elements like cartilage or bone. Infected tumor tissue, cicatricial tissue and fibrosis, either from operation, previous radiation or other sources, always interfere with the normal reaction—a result which we often see in the rodent ulcers of the face because of a previous inadequate treatment. The softening and breaking down of tumor tissues from a nutritional disturbance, occasionally when the patient is in a good general condition, interferes with a normal reaction, and radiation only hastens the necrosis and prevents the normal reparative process. Anæmia with or without cachexia, also, may so alter the normal radio-sensitive qualities of a tumor that a therapeutic test is of no value. It is, in fact, upon the observation of these altered reactions that Ewing has partly based his conclusions relative to the importance of the reparative process in the radiation cure of cancer.

Recognizing, therefore, the factors that may alter the normal reaction of radio-sensitive tumors, our experience shows that the use of the X-ray and radium as a therapeutic test has a special value in the differential diagnosis of the tumors of the lymph-nodes of the neck, often enabling us, if observed in conjunction with the clinical setting, to distinguish between nodes expressing an infective process like tuberculosis and neoplastic nodes secondary to a primary cancer of the mouth, and those expressing the existence of one of those diseases which have been designated as lympho-blastoma, under which we have included lympho-sarcoma, Hodgkin's disease and lymphatic leukæmia. Our experience now extends over a period of ten years, during which we have observed about 1,000 cases of the last three diseases. A large number of these cases have been referred to us with the diagnosis already made from the microscopic section of nodes that have been excised for the purpose of diagnosis. During the early years of our work such was our custom of confirming the clinical diagnosis, but we now rarely excise a node for this purpose because—

(1) The information from the pathologist is often not positive.

(2) Infection frequently follows and the normal regression of the tumors is disturbed.

(3) As our experience has increased we find the reaction of these tumors to the X-ray and radium is so specific that the subsequent course of these cases has usually confirmed the diagnosis we have made in this way.

The differential diagnosis of these diseases is often difficult clinically and may be impossible. Their inter-relationship must also be admitted to exist. We observed, for example, a lympho-sarcoma for seven years, the diagnosis of which had been made by a microscopic section, and which finally terminated under the typical clinical picture of lymphatic leukæmia. It is in the clinically doubtful cases that the pathological report is also doubtful. In other words, a case that is clinically typical of Hodgkin's disease will be so reported by the pathologist, and a case clinically atypical will be reported by the pathologist, also, almost invariably as atypical. A patient referred from another clinic with the diagnosis made from an excised node as Hodgkin's disease (lympho-sarcoma type) illustrates again the difficulty of the pathologist. But in this case the rapid and complete regression which followed the X-ray treatment gave the only positive information regarding the nature of the disease, which undoubtedly was a lympho-sarcoma. The diagnosis of the pathologist depends upon his interpretation of the section, but the regression of the tumor requires no such difficult histological interpretation.

It is not our purpose to show that a microscopic diagnosis is always unnecessary or harmful, for there are numerous clinical settings in which an early and exact diagnosis by the pathologist is necessary for the proper treatment of the case. In the nodes of the neck, however, it is difficult to exaggerate the frequency with which infection and increase of growth activity result from biopsies. In the case of lympho-sarcoma, it is nearly a constant sequel. A boy, the son of a physician, applied to the hospital for radium treatment of a bulky tumor of the neck, in the centre of which a biopsy had been done and from which a diagnosis of lympho-sarcoma had been made two weeks previously. The tumor had grown much faster since the biopsy, and at its site there presented a fungoid bleeding mass, from which already two serious hæmorrhages had occurred. After the application of radium the periphery of the tumor immediately regressed so that within ten days little of the tumor could be felt except the central fungoid mass, from which a subsequent hæmorrhage, in conjunction with a general toxemia, caused his death. Such events are not rare, nor is it a fanciful interpretation of the sequence of events, for many have observed stimulation of the tumor cells by bacterial infection and interference with the tissue repair that is normally induced by radiation. It does not materially lessen the force of the argument to note that in a typical Hodgkin's case a node may be excised with little, if any, harm.

Our experience has enabled us to distinguish between the radiation reactions of lympho-sarcoma, Hodgkin's disease and lymphatic leukæmia. A typical lympho-sarcoma regresses completely within a few days or weeks,

Hodgkin's nodes within a few weeks or months and not always completely, while the nodes of lymphatic leukæmia usually show more resistance and rarely, if ever, is the regression complete. The Hodgkin's nodes show the greatest variations in their radiation reaction, which is undoubtedly due to the variations of structure. Hodgkin in his original description of the disease directed attention to this fact and that they are usually more cellular at the beginning of the disease. The specific quality of the radiation reaction is illustrated by a few cases which resemble true lymphatic leukæmia in the general distribution of discrete nodes throughout the superficial lymphatic system but without the localization of bulky nodes as observed in Hodgkin's disease, and without the blood picture of lymphatic leukæmia. Their reaction to radiation was less favorable than those of Hodgkin's disease, showing practically the same reaction as those of true lymphatic leukæmia. A microscopic section of these nodes invariably gives the picture of pseudo-leukæmia—the radiation reaction, therefore, adding evidence to the generally accepted idea that pseudo-leukæmia is distinct from Hodgkin's disease.

Finally, we wish to direct attention to the applicability of the therapeutic test to those nodular tumors of the neck which are associated with lesions of the tonsils. These cases first apply to us usually after the tonsils have been removed and the nodes of the neck have increased in size since their removal. Or less often, they appear after both the tonsils and the nodes have been removed and a recurrence of nodes in the neck has appeared. A microscopic diagnosis on the tonsils is rarely made so that the incidence of lympho-sarcoma of these organs is unknown, but it has appeared to us that it may be more common than is generally believed. In this tumor a biopsy or a tonsillectomy is a definite menace, because, no matter how definitely localized the tumor appears to be, the surrounding lymphatic structures are always involved, so that even without infection the operation will act as a stimulus to growth activity. A dosage of X-ray or radium sufficient to make a therapeutic test will produce no changes that will make a subsequent operation more difficult or less successful. Among our cases were two otherwise apparently healthy young patients with enlargement of the tonsil and nodular tumors of the neck, which clinically appeared to be typical of lympho-sarcoma, but which might perhaps be regarded by those less familiar with that disease as simple hyperplasia from an infection. One application of the X-ray resulted in a rapid and complete regression. Both of these cases, with the exception of a slight discomfort from dryness of the throat, have remained well for two years. We have no microscopic proof of the exact nature of these tumors, but we know that neither hyperplasia of the tonsils nor of the lymph-nodes responds to radiation in any such way. In hyperplastic nodes from infection there is always an inflammatory reaction without a subsequent regression, which is not observed with malignant neoplasms. If, for example, a tuberculous-node has reached the stage of pus formation without appearing as such clinically, radiation will promptly make the abscess formation plainly apparent. The rapid regression in these cases also shows that

the nodes were not a squamous cancer. They might be regarded as belonging to the transitional type of cancer. Our experience with the radiation reaction to this type of tumor is too recent to permit us as yet to form an accurate judgment of its radiation reaction. At the present time it does not appear to be so constant as that of lympho-sarcoma. The subsequent course of our cases, also, rather confirms the diagnosis of lympho-sarcoma. The features, also, of the primary lesions of the tonsils, marked and uniform enlargement without ulceration, seems to differentiate them from the transitional-cell type, in which ulceration, although it may be slight, usually exists and can be differentiated from lympho-sarcoma. Moreover, our experience with other similar lesions, in which the diagnosis has been confirmed by a microscopic section and in which the primary regression has been the same, leads us to believe that our diagnosis is correct in these cases.

In conclusion our experience indicates that the regression of tumors under radiation is not an accidental or chance phenomenon, but depends upon the structure and nature of the tumors.

With certain tumors the reaction to radiation is so marked, so constant, and so specific, as to make this reaction a valuable aid in diagnosis, so that diagnosis by microscopic section becomes unnecessary. At times, when the microscopic structure is difficult to interpret, the results of radiation may support or alter the histological diagnosis.

VALUE OF METHYLENE BLUE-GENTIAN VIOLET 5 PER CENT. IN PREOPERATIVE SKIN PREPARATION

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Preliminary to a study of the rationale of the treatment of intraperitoneal inflammatory disease, we took cultures from the peritoneal cavity of apparently clean cases. So many of these cultures were positive that we felt there must be some point of contamination between the skin surface and the peritoneum.

We had always considered that scrubbing the skin with ether and then painting it with 2 per cent. iodine in alcohol was sufficient to produce immediate sterility, but cultures taken from the skin so prepared yielded positive results. We changed our preparation material to 2 per cent. iodine in carbontetrachloride, then to 5 per cent. picric acid, then to 5 per cent. mercurochrome, but positive cultures still persisted. Five per cent. neutral acriflavine gave fewer positives but not consistent sterility.

Since one of the most important factors in wound contamination is the patient's skin, we were much surprised to find that out of the mass of literature on skin preparation very few authors had subjected the various substances which they advocated to severe laboratory and clinical tests. Other factors involved in the operation of the usual clean case are now so carefully controlled that they can rarely be blamed for the appearance of pus in a wound, so absolute skin sterility is essential.

We fear that surgeons too often leave the choice of the substance they use for skin preparation to habit, or the glowing claims of drug houses.

The development of the methylene blue-gentian violet 5 mixture is the result of our attempt to produce a positive skin antiseptic to replace those which were only partially effective.

It is probable that no operation is ever performed under absolutely aseptic conditions. Wounds are contaminated because bacteria in such large numbers or of such virulent strains are introduced into them that the tissue resistance is overcome.

The use of aniline dyes as an antiseptic is rapidly becoming popular. Tinker and Churchman have contributed more to the literature of the subject than any other American writers. Churchman's work has in the main been theoretical, or rather from the standpoint of the bacteriologist. But Tinker has for many years advocated their use as a preparation of the skin before operation. The solution which Tinker advocated was 5 per cent. gentian violet and 5 per cent. neutral acriflavine in 50 per cent. alcohol. There are two objections to this solution: first, it is unstable and, second, a

factor which cannot be neglected in this day of hospital economy, it is extremely expensive.

In thinking over Tinker's article, it occurred to us that all of the properties of neutral acriflavine are enjoyed by methylene blue, a substance which has been used as an antiseptic in many ways previously, and it occurred to us to try to substitute it for acriflavine and see what happened. We had seen it used on the skin by Bonny in London.

The substance which resulted from this substitution, which we call MBGV5, is a solution containing 5 per cent. commercial methylene blue crystals, 5 per cent. commercial gentian violet crystals in 50 per cent. commercial grain alcohol. This solution is readily made stable over a period of months and costs about seven cents an ounce to make up in a hospital.

The ideal substance for preoperative skin sterilization must answer the following requirements:

1. It must kill the common skin-contaminating organisms immediately. It must inhibit the growth of, or render non-virulent, any of the uncommon skin-contaminating organisms such as the anaërobes.
2. It must retain its ability to sterilize for at least one to two hours.
3. It must be readily visible in order that its limits may not be mistaken.
4. It must be non-toxic and non-irritating to the skin.
5. It must not interfere with the reparative processes.
6. It must be stable.
7. It must not interfere with the physiology of the skin.

It seemed to us that the best method of testing the efficiency of the skin antiseptic was to subject it to conditions similar to those which it must meet in the course of an operation. The determination of the phenol coefficient of an antiseptic is not sufficient as a recommendation. As surgeons, what we want to know is when an antiseptic is brought in contact with the bacteria on the skin, does it or does it not render that skin aseptic? Can we make an incision through that skin area and not carry into the subcutaneous tissues bacteria which will later on produce a wound infection? The effect of an antiseptic on bacteria in a test tube and under laboratory conditions may not be the same as its effect upon similar bacteria when in their natural habitat.

With this in view, it seemed to us that we must subject MBGV5 to conditions which closely similate those that arise during the course of a surgical procedure. Our first step was to determine what standards of asepsis we would use, and what our technic would be to determine the effect of the antiseptic on skin bacteria. Almost every article advocating the use of a special skin antiseptic offers a special technic. After carefully considering them we decided that they must all be rejected because the technics described depended to too large an extent upon the personal factor. For instance, if after the application of an antiseptic the skin is scraped with a sterile knife and these scrapings culture, it is obvious that the intensity with which the scraping is performed is an extremely variable factor. The same criti-

cism applies to the rubbing of swabs or other instruments upon the skin after the antiseptic has been applied, and dropping it into culture material. This is a procedure which is practicable only on experimental animals, as it adds to the scarring and increases slightly the operative risk.

We decided to adopt the following method of skin culturing because it is applicable to use during the course of any operation, and is practically individual proof.

Cotton was wound onto wooden applicator sticks to make swabs of equal size. By having the same individual make these, the area of the tip of the swabs is remarkably uniform. They were sterilized in batches of 200 in large test tubes. Two controls were taken from each batch. About one inch of beef infusion broth (Ph. 7.2 to 7.6) was placed in four-inch tubes, numbered and sterilized in racks.

When the culture was to be taken from the skin of the patient, the following method was always employed: The sterile swab was moistened in sterile media, the swab was then held in contact with the skin without rubbing or using more pressure than was necessary to hold it in place for thirty seconds by a stop watch. The swab was first thoroughly rinsed off in a tube of media and then discarded. The media tube was flamed every time it was opened. The tubes containing the media were then incubated at 37° Centigrade for five days. Those which showed any cloudiness whatsoever were examined microscopically and the organism identified. (We call attention to the fact that this technic leaves practically no room for variation.)

We selected as our subject children and adults who were recuperating from non-surgical conditions. The abdomen was divided into five sectors by lines drawn with the dye radiating from the umbilicus. Cultures were taken from each of these areas as controls. Of 233, eighty were positive.

Five antiseptics were tested by applying one to each of the sectors of skin, the application was made with a sterile swab, the sectors were rotated, and cultures were taken by the previously described method at ten-minute intervals for one hour.

We cannot fail to take into consideration the fact that during the course of an operation, whether it be under general or local anæsthetic, the skin of the patient is constantly perspiring. This means that bacteria are being brought up from the depths of the sweat glands and the hair follicles and poured onto the skin surface. Some of the antiseptic used should be on the skin surface ready to meet these organisms during the entire course of the operation. If those who use iodine will bear this fact in mind, unless the iodine has been used in seven-and-one-half strength and not rubbed off with alcohol, a procedure which is extremely apt to produce severe skin reactions, they will notice that at the end of the operation, if it is over an hour in duration, the iodine stain has practically disappeared. And if they will take cultures from the skin at this time they will find that growths of staphylococci and streptococci can be obtained.

Some skin antiseptics such as picric acid had been advocated on the

ground that they tanned the skin and that through this tough, leather-like covering bacteria could not gain access to the surgical area. The efficiency of this method cannot be criticised theoretically, but it is at once apparent that if this coating is lacerated, this method of sterilization is immediately rendered useless. Such lacerations, due to the presence of instruments or rubbing the skin, cannot be avoided. In using MBGV5, which is a very noticeable stain, we have frequently observed that an area of about one inch on each side of the incision will be almost white when the operation is finished, which goes to show that the tendency to rub materials off this area is considerable.

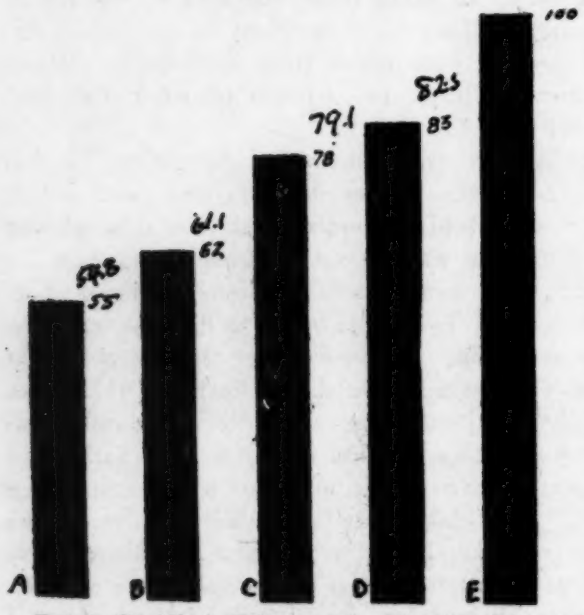

FIG. 1.—Graphic chart showing the comparative efficiency of the five antiseptics used in the previous experiment. A, ether; B, 2 per cent. mercurochrome; C, 3 per cent. picric acid; D, 2 per cent. iodine; E, MBGV5.

We mentioned the fact that our ideal skin antiseptic must maintain its potency for at least one to two hours. Hence all of our tests were conducted for at least an hour and some of them for two and one-half hours, during the course of which the skin was not protected in any manner and was left open to contamination as it would occur in the wards of general hospitals.

We have now defined the requirements of our ideal antiseptic and specified the conditions under which the efficiency must be tested.

We proceed to recount our experiments.

The five antiseptics tested were ether, 2 per cent. mercurochrome in aqueous solution, 3 per cent. picric acid, 2 per cent. iodine in alcohol, and MBGV5.

A consideration of the foregoing led us to believe that in MBGV5 we had an antiseptic of extreme efficiency, but we were not satisfied. We determined to subject it to more rigorous conditions by adding fresh cultures of bacteria in order that we might be sure that we were dealing with skin which was actively contaminated. Naturally we felt that we were not justified in doing this on humans until we had first tried it on the skin of laboratory animals. Rabbits were used, the experiment being conducted as follows:

On the day preceding the experiment the abdomens of the rabbits were

clipped and all the hair removed by shaving, care being taken not to lacerate the skin. The animal was tied down on its back on a board and the abdomen marked off into four sections. Twenty-four-hour cultures containing staphylococci and streptococci from a carbuncle B. subtilis from the laboratory strain were rubbed onto these areas and allowed to dry for one minute.

Material used to disinfect unprepared skin	Time after application of disinfectant cultures taken	Number of times tried	Number of negative growths obtained	Percentage of negative growths obtained
Ether	10 min.	47	31	69
Ether	20 min.	47	24	51
Ether	30 min.	47	30	63
Ether	40 min.	47	20	42
Ether	50 min.	47	23	48
Ether	60 min.	47	26	56
		Total 282	Total 154	Average 54.8
Mercurochrome 2%...	10 min.	47	29	62
Mercurochrome 2%...	20 min.	47	28	59
Mercurochrome 2%...	30 min.	47	29	62
Mercurochrome 2%...	40 min.	47	31	66
Mercurochrome 2%...	50 min.	47	29	62
Mercurochrome 2%...	60 min.	47	26	55
		Total 282	Total 172	Average 61.1
Picric acid 3%.....	10 min.	47	42	89
Picric acid 3%.....	20 min.	47	36	77
Picric acid 3%.....	30 min.	47	42	89
Picric acid 3%.....	40 min.	47	34	75
Picric acid 3%.....	50 min.	47	39	83
Picric acid 3%.....	60 min.	47	29	62
		Total 282	Total 222	Average 79.1
Iodine 2%.....	10 min.	45	40	88
Iodine 2%.....	20 min.	45	37	82
Iodine 2%.....	30 min.	45	37	82
Iodine 2%.....	40 min.	45	40	88
Iodine 2%.....	50 min.	45	38	84
Iodine 2%.....	60 min.	45	32	71
		Total 270	Total 224	Average 82.5
Methylene blue 5%...	10 min.	47	47	100
Gentian violet 5%...	20 min.	47	47	100
	30 min.	47	47	100
	40 min.	47	47	100
	50 min.	47	47	100
	60 min.	47	47	100
		Total 282	Total 282	Average 100

Control cultures were taken immediately, all of them being positive. Each of the four areas was then painted with an antiseptic as in the previous experiment. The antiseptics used were the same except that we did not test ether alone, we increased the percentage of mercurochrome to 5 per cent. Cultures were taken from each of these areas by the usual method at half-hour intervals for two and one-half hours. These cultures were then incubated for five days and the results recorded. This procedure was carried out on two areas on each of five animals.

In selecting the bacteria to add to the skin we chose staphylococci and streptococci because they are common skin contaminating organisms and added B. subtilis for two reasons: (1) because it is air-borne and (2) because it is a gram negative spore bearer. We increased the duration of the experiment to two and one-half hours because that is the maximum time required for major surgical procedures.

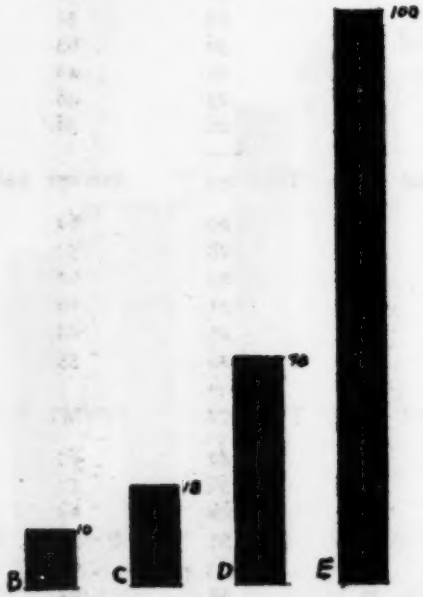

FIG. 2.—Graphic chart showing the comparative efficiency of the four antiseptics used in the previous experiment. B, 5 per cent. mercurochrome; C, 3 per cent. picric acid; D, 2 per cent. iodine; MBGV5.

From a consideration of the foregoing results we felt that we were justified in continuing our investigation to the extent of adding the same bacteria to human abdomens. In order that we might not leave a skin which was abnormally contaminated, at the close of each experiment the entire area was painted with MBGV5. All of these control cultures were negative.

Hill and Scott (*Journal of Urology*, Aug., 1925, p. 135) recommend the use of 2 per cent. mercurochrome in a solvent containing water, alcohol and acetone. The following is a table showing the result of a comparison of this antiseptic with MBGV5. The subjects were human medical convalescents; the bacteria added to the skin were staphylococci, streptococci and B. subtilis. The abdomens were divided into six areas, three of which were painted with mercurochrome, acetone and alcohol, and three with MBGV5.

	Areas painted	Control	15 min.	30 min.	45 min.	60 min.	75 min.
Mercurochrome, Acetone, Alcohol	48	48+	27—	22—	24—	25—	35—
MBGV5	48	48+	48	48	48	48	48

Under the same conditions as the preceding experiment we compared

the efficiency of MBGV5, 5 per cent. neutral acriflavine in acetone alcohol solvent and a proprietary antiseptic (x) dilution of one-five-hundredth.

We tried reducing the percentage of methylene blue and gentian violet from 5 to 4, 3, 2, and 1, and found that 5 per cent. was the least concentration at which the antiseptic was 100 per cent. efficient according to our standards.

In the preceding experiments we have subjected MBGV5 to the most difficult tests which simulate actual clinical conditions and find that in it we have an antiseptic which gives us better results than any with which we have compared it. We are now using it as a routine skin preparation, its application being preceded by a thorough scrubbing of the skin with ether. This we believe is a procedure of the utmost importance, as by it a large portion of the sebaceous material and fat is removed from the skin, giving the dye a chance to penetrate into the recesses of the glands and follicles in the skin.

FIG. 3.—Graphic chart showing the comparative efficiency of four antiseptics used in the previous experiment. A, mercurochrome 5 per cent. aqueous solution; B, 5 per cent. neutral acriflavine in acetone alcohol solvent; C, (x) 1–500 aqueous solution; D, MBGV5.

Cultures taken from under pads which have been on the patients during the course of major operations when the skin was prepared with MBGV5 have been consistently negative. In using it on over three hundred clean abdominal cases over a period of one year we have reduced our incidence of wound infection to less than 1 per cent. In this series we have not included any drained cases, or cases in which infection was present within the peritoneum, although this cavity was not drained. To those interested in using the dye we offer the following suggestions: (1) Since it is such an intense color, as soon as the skin incision is made the skin should be protected with drapes in order that the dye may not be carried down into the tissues on the instruments or surgeon's gloves, thus discoloring the organs

with which it comes in contact, especially when the surgeon depends upon the color of the organ to aid his diagnosis. (2) It can be used without fear of burning or blistering the patient's skin. (3) It is stable for at least a month. (4) It is a true solution and does not require shaking before use. (5) It should be applied to the skin on small sterile swabs held in sponge holders. These swabs or sponges should be discarded into paper bags in order that the stain may not spread to towels and other linen. (6) The dye should not be removed from the skin under the dressings immediately over the wound, but may be removed from the other areas of the abdomen by wiping it off with sponges soaked in "hypozone", after which the skin should be washed with alcohol, as "hypozone" sometimes irritates. (7) The dye can be poured into abscess cavities and when thus used is a highly efficient aid in reducing the amount of infection. (8) If some of the dye gets into the peritoneal cavity the urine during the next twenty-four hours may be bluish. (9) The dye does not interfere with reparative processes.

We feel that MBGV5 meets all of the requirements for an ideal pre-operative skin disinfectant because: (1) We have shown that it does kill the common skin contaminating organisms immediately. (2) We have shown that it will retain its ability for sterilization for at least two and one-half hours. (3) It is readily visible. (4) Experience has shown that it is non-toxic and non-irritating to the skin. (5) It does not interfere with the reparative processes. (6) It is stable for at least a month. (7) It does not interfere with the physiology of the skin.

To summarize our results. During the past year our records show 277 clean abdominal cases in which MBGV5 following an ether scrub was used as a skin preparation. Of these cases three became infected. One was a Pfannensteil incision in which an operation for bilateral salpingitis, acute, was done. The fat infection which followed may have been due to the pelvic pathology. The second case was a chronic appendix in which a fat infection occurred for which no explanation can be offered. The third case really does not belong in this set of figures at all, because one of the operators in an attempt to lessen the amount of staining, tried to remove the dye with "hypozone" immediately after it was applied.

This work is done under the auspices of the Surgical Research Department of the Department of Surgery, at the Fifth Avenue Hospital.

THE ALCOHOLIZED NERVE GRAFT

AN EXPERIMENTAL STUDY

By Paul W. Sweet, M.D.
of Centralia, Washington

Bridging nerve gaps is a problem surgery has been attempting to solve for many years. In the light of modern proof as to the manner of growth of the neuro-fibrillæ, many of the methods tried for bridging the gaps have been discarded, and the many methods proposed by numerous more recent investigators is ample proof that the problem is still unsolved. Bringing the two ends of a nerve together inside of formalized arteries, decalcified bone tubes, fresh arteries and veins, celluloid tubes, and fascial tubes have each had their advocates. Neuroplasty, heterogenous and autogenous grafts, bridging the gap with catgut and silk have consistently disappointed. The Medical Research Committee of The British Medical Association investigated many cases of nerve grafting and failed to find one single case of complete recovery, and concluded that end-to-end suture is the method of choice in every case even if resection of bone is necessary for its accomplishment. A brief review of the literature on nerve degeneration and repair may afford a fuller view of the subject.

Peripheral nerve degeneration is a constructive as well as a destructive process. As the neuraxon and its myelin sheath break down and gradually become absorbed, the cells of the fibrous supporting tissue—which constitutes 62 per cent. of the nerve trunk—and also the cells of neuralemmal sheath, begin to rapidly proliferate and rapidly take the place of the part absorbed.

In 1852 Waller advanced the theory that a peripheral nerve, when separated from its trophic centre, the cell, completely degenerates and that regeneration is only from the central stump whose neuraxons are still connected with the central trophic cell. Because of inadequate staining methods he was not able to prove his theory and demonstrate it under the microscope, and it was so hotly contested and his arguments so overwhelmingly battered down that it failed of even a semblance of acceptance. During the years that immediately followed two other theories gained sway and clinical evidence was sufficient to make it impossible to overthrow them, and it was not until Cajal in 1904 brought out his silver stain that the correct theory of Waller again gained recognition and stands to-day as an almost universally recognized fact.

In 1892 Howell and Huber very thoroughly reviewed the literature and found that up to that time three theories had been advanced.

(1) Waller's theory, that that portion of the nerve which has been divided and thus completely separated from its trophic centre completely degenerates, and regeneration is from the undegenerated proximal stump which still remains intact with its trophic cell.

(2) A peripheral axon of a divided peripheral nerve does not degenerate and all that is necessary to regenerate a nerve is to approximate the cut ends which will unite and a new myelin sheath form.

(3) The peripheral axons of a divided nerve degenerate but regeneration takes place throughout the nerve at the same time. In the protoplasmic bands which appear all along the nerve there arise discontinuous fragments of axons which fuse and form the new axons.

In the absence of positive proof of its incorrectness there was so much clinical evidence to substantiate the second theory that for a long time it held recognition; and there is much evidence in the more recent literature to make us stop and question if perhaps in certain instances the peripheral stump does not degenerate. Among the instances on record of a prompt return of function after nerve suture is one reported by Heekes in 1918, where the function of the ulnar began definitely to return six days after suture, the nerve having been shot in two at the internal condyle seven months previously.

In Heekes' article in references, Professor Waller in a letter written in reply to an inquiry concerning such cases says, "in those few cases of prompt recovery which have been recorded no satisfactory explanation has been offered. I am inclined to think that prompt recovery may be due to the stirring up by the operation itself of recurrent sensory fibres belonging to other nerves that may form part of the peripheral distinction and may have had their action in abeyance during complete paralysis before operation." He also adds, "Increased knowledge in the present day of the extensive halo of functional disturbance aroused by an organic focus of real injury would lead me to be on the watch for the possibility of prompt reappearance of sensation by the cerebral suggestion as well as by the peripheral excitation afforded by the operation itself." In taking observations there is a strong personal factor so that some allowance must be made for inaccurate as well as incomplete observation. These apparent exceptions to the rule should bear no weight, however, in our views on the subject of nerve regeneration, for the evidence is too great in favor of the Wallerian theory.

By his histological study von Bungner began the modern investigation in 1891, the year previous to Howell and Huber's work. These were followed by Stroebe (1893-1895), Huber (1895), Ziegler (1896), Galcotti and Levi (1895), Kennedy (1897), and Wieting (1898); all of whose work was from a histological study, yet the real nature of the regenerative process was not shown.

Bethe's publication was of a series of experiments in which the peripheral was separated from the central end first by pulling out the sciatic from the cord and cutting it off far down the thigh and second by cutting three centimetres out of the nerve and bringing the central end up through a muscle. He concluded that these two methods produced the same results. In his conclusions he maintained that there were five stages in the regeneration of nerve fibres. First, that of protoplasmic band formation. Second, differentiation of these bands into axial strands and granular sheaths. Third, appearance of fibrils in the axial strands in the neighborhood of the nuclei. Fourth, fusion of these discontinuously formed fibrils into the fibrillar bands. Fifth, discontinuous formation of a myelin sheath. More recent findings have shown that the first stage only as outlined by Bethe was correct.

In 1893 Stroebe, by the use of his own stain, showed that the neuraxons were outgrowths of the central stump of the intact nerve. He did not, however, show what relationship existed between the protoplasmic bands of von Bungner and the newly-formed neurofibrillæ, but found that the myelin sheath grew from above downward. Two years later Huber (1895), by the use of Stroebe's stain, obtained better pictures than did Stroebe and was the first to demonstrate the small bulbous endings of the most distal portion of the down-growing fibrillæ.

Wilson classifies the degeneration of nerves into three stages. First, there is granulation of the axis cylinders and breaking up of the medullary sheath at the intersegmental lines of Schmidt and Lantermann. The axis cylinders become coarsely granular and the myelin sheath is broken up into fragments. While these processes continue to take place the neurilemma nucleus increases in size and the surrounding protoplasm becomes more abundant. In a normal nerve there is but one nucleus to each neurilemmal internodal segment. In a degenerating nerve mitosis occurs and more than one nucleus lies in a single segment. The second stage is merely a continuation of the processes begun in the first. The myelin and the axis cylinders entirely disappear and the neurilemma nuclei are exceedingly abundant. The third stage is characterized by a marked increase in the protoplasm around the nuclei. This protoplasm increases in amount, forming spindle-shaped homogeneous masses which become confluent and differs from the ordinary cytoplasm in that it is nongranular and stains poorly, thus closely resembling embryonic fibres.

Ingebrigtsen studied the cut ends of a nerve which was incubated in plasma and showed that there grows out from the cut ends of a nerve fibre numerous thin filaments of protoplasm, which are at first tapering and end in a point which shows amæboid movements by means of which they enter the plasma. He also showed that hyperplasia of the neurilemma was only present in those nerves where degeneration had begun. This would seem to prove Nageotti's (1911) contention that the myelin in digesting the axis cylinders furnish the stimulus for the beginning hyperplasia of the neurilemmal sheath nuclei, which theory on the other hand is pretty well upset by Clark's experiments in feeding animals polished rice, thus obtaining the degeneration in the myelin and axis cylinders without change in the neurilemma.

Ranson made a most exhaustive and thorough study and review of the whole field of degenerating and regenerating nerve fibres, and his conclusions are so inclusive and so clearly stated that I give them in full as they probably come the nearest of any in stating the present-day status.

(1) Cajal stain shows that the axons when they first make their appearance in the distal stump are fully developed and clearly differentiated from the surrounding protoplasm. They do not appear as discontinuous fragments arising as new axons in protoplasmic bands through a fusion of longitudinal striations which have developed *in situ*, as was first maintained by Bungner, but are long fibres which when traced peripherally may end within a protoplasmic band with a terminal bulb, and when traced centrally may run out of the section or into a plexus of axons in the scar. Many writers have reached this same conclusion. Perroncito, Marinesco, Poscharissky, Cajal, using the Cajal stain, and Kassin with methylene blue, and Pupura with the Golgi stain.

(2) The attempts to obtain regeneration in the peripheral stump permanently separated from the spinal cord and spinal ganglia have led to negative results. So great is the regenerative energy of the central stump in young animals that the new axons to which it gives rise may bridge very great gaps to reach the distal stump, and new axons may grow in that stump from other nerves.

(3) Axons of both medullated and nonmedullated fibres in the central stump give rise to a large number of branches which make their way through the scar and enter the protoplasmic bands which they use as pathways to the periphery.

(4) The axons of the peripheral stump do not die at once after the division of the nerve, but live for two or three days at least, and undergo changes in the neighborhood

of the lesion which must be regarded as an abortive regeneration. After a few days all the newly-formed structures degenerate and disappear. Confirmed by Perroncito, Poscharissky, Marinesco, and Cajal.

(5) Alterations in the axons of the proximal stump can be noticed within twenty-four hours after the lesion. Fine branches are formed and the rearrangement of the neurofibrils of the old axons to form the most complicated networks. These changes occur in the immediate neighborhood of the cut surface and are too varied to summarize in detail.

(6) These phenomena concern the nonmedullated fibres which outnumber the medullated fibres in the spinal nerves.

Kirk and Lewis (1915) have studied the regeneration of nerves, using a fascial tube as a conduit between the two ends of a cut nerve, which they have found fills in from one to twenty-four hours with a jelly-like substance appearing grossly like brain substance but microscopically is of a gelatinous nature with a few white blood cells. Into this substance grow the protoplasmic bands which are at first isolated masses of cytoplasm but which tend to become more protoplasmic as hyperplasia advances. These bands grow downward into the gelatinous mass and form pathways for the neuraxons which grow out of the proximal end of the cut nerve. These begin to branch as high up as two centimetres above the upper end of the section and the nonmedullated ones appear in great numbers, but the branches from the medullated ones predominate, although all medullated first appear as nonmedullated fibres. They state that often there are from 50 to 100 times as many axis cylinders as are present in the nerve several centimetres above the point of section, though they are only about one-tenth the diameter. Each ends in a bud which can be seen at different levels.

Lewis and Kirk confirm Ranson's findings in that the axis cylinders appear first as nonmedullated naked fibres, which spring from either the medullated or nonmedullated cut fibres. They found that the protoplasmic bands grow at the rate of about two millimetres a day, while the axis cylinders grow only one millimetre in three and a half days. A one-centimetre gap was bridged in five weeks. About the sixth week the naked axis cylinders begin to acquire a myelin sheath.

It is well that so many more axis cylinders appear than are normally present, for they do not always follow the protoplasmic bands into the distal end of the nerve, but are lost in the scar or may pass out into the adjoining structure, or may pass down beside the nerve for some distance before passing out into the adjacent structures. Vulpius and Stoffe have shown that if only a comparatively few axons reach the muscle end plates the function of the muscles will be resumed. It must be borne in mind that a muscle capable of function is essential, for no matter how well the neuraxons proliferate function could not be restored if myositis or other degenerative changes have taken place in the muscle.

In their recent article (1917) Kirk and Lewis state that the myelin sheath regenerates from above downward, but whether its origin is from the axis cylinder, the neurilemma, the protoplasmic bands or from none of these is not shown, but they do show that it does not appear in any part until the axis cylinder has been present for at least five weeks and in many of the fibres it appears much later.

Greenman (1916) in studying the regeneration of traumatized nerves found an increase of from 64 to 249 per cent. (maximum increase then would be less than three times normal) in the number of fibrillæ in the regenerated nerve. He showed that on passing from the proximal end of the operated nerve the number of fibrillæ rapidly increase as the region of the lesion is approached, and from the region of the lesion distally the number decreases, but he found that there was a loss of 42 per cent. in the sectional area of the regenerated fibres.

J. E. Sweet (1916) found that enclosing the nerve in a celluloid tube kept the fibres from interlacing, and concluded that the indestructible protecting tube favors rapid and

direct regeneration and has also the added marked advantage of eliminating practically all of the connective tissue interference.

The experiments which I have performed were done with the thought of proving or disproving the contentions of J. Nageotte and L. Sencert in their several papers, namely, that they "shall show how the dead heterogeneous nerve grafts are able to give forth elastic results as good as autogenous living grafts." Nerves from the sciatic, brachial plexus, and vagus of a fœtal calf almost to term (60 to 70 centimetres in length) were removed aseptically and tied to a glass miscroscopic slide so as to keep them straight. These were placed immediately into 80 per cent. alcohol and after twenty-four hours were taken from the glass slides and sealed in test tubes with 50 per cent. alcohol enough to cover them well. No attention was given as to the proximal or distal end of the graft. All technic was aseptic.

Twenty-one dogs of varying ages and sizes were operated on. The thigh of the dog having been properly prepared was opened, care being taken not to produce any more trauma than absolutely necessary. The lines of cleavage were followed in separating the tissues, so that in but very few instances was there any hæmorrhage. The sciatic nerve was elevated out of its bed and by careful sharp dissection it was freed for a distance of four to six centimetres from a point just below the sacrosciatic notch to a point one-half to two-thirds down the thigh, and a clamp placed on that part of the nerve to be removed. Two fine straight needles carrying single strands of very fine Japanese silk were passed through the nerve, one above and one below the forceps and about one and one-half to three centimetres apart. With a sharp cataract knife or safety razor blade the segment held by the forceps was removed, it being cut as near the inserted silk sutures as safety would permit.

The alcoholized nerve, having been soaked in Ringer's solution for half an hour, was held at each end by a pair of forceps, and these same fine needles carrying the fine silk were passed through the graft while being held taut with the forceps, the sutures being placed so that the graft when cut would take the place of the part removed without tension. The graft was then cut off squarely with the sharp instrument. By the time this had been done the slight amount of oozing, which usually occurred from the proximal end of the dog's nerve, had ceased, and if so the graft was put into position and the silk strands loosely tied. Two more sutures were then placed so as to include the nerve sheath only and these sutures were just a trifle more snugly tied. The nerve was now dropped back into place between the muscle sheaths and the wound closed without drainage. Hæmostasis was as nearly perfect as possible before closure was effected. The wound was painted with tincture iodine and no dressing applied.

Results.—Specimens were removed at intervals of from seven days to seven months following operation. One dog has not yet been sacrificed. In those dogs which were sacrificed early no electrical stimulation was applied to the nerve at autopsy. A piece of the nerve two to three centimetres above

and three to four centimetres below the graft was removed for microscopical study. The first specimens were split longitudinally and one-half of the nerve stained with silver pyradine (Ranson's modification of the Cajal stain) and the other with hæmotoxylin and eosine. These were embedded in paraffine and cut longitudinally. As the work progressed it was found that in some of the nerves the regenerated fibres were missed, if any had appeared, so the splitting of the nerve was discontinued and only the silver stain was used. In each later autopsy more nerve was removed below the graft and the specimen stretched and tied on a long piece of glass. Blocks were cut from the nerve and sections made both longitudinally and transverse to the nerve fibres. This was a much more satisfactory method and more inclusive.

No dogs died and no wounds became infected except one which was torn open while the dog was in a fight. Three dogs chewed their legs off up to their knees following the appearance of the trophic ulcers on their feet and these dogs were sacrificed early. Two dogs were allowed to live seven months and both of these had regained the power of dorsal flexion of the foot. One of these, however, had marked trophic disturbance and the foot was twice its normal size. Dog No. 1354 obtained apparently a perfect functional result. The operation was performed on June 21, when three centimetres of the left sciatic was removed and an alcoholized graft from the fœtus of a calf was inserted and held in place by two silk sutures at each end of the graft. The dog developed no trophic ulcers but walked with a decided limp until and sometime after September 20. I did not again see this dog until January 20, at which time she was fat, very frisky and used both hind legs equally well. She was so playful and full of life it was almost impossible to take her picture.

All the dogs with the exceptions noted did exceedingly well, though all walked on the backs of their toes which became sore until the dog learned to protect the affected foot by holding it up and walking on three feet, which some of them early learned to do.

The nerves were examined grossly and microscopically. Upon opening up the tissues the first thing that was noted was that there were, as a rule, very few adhesions to the surrounding structures. This was more striking in some cases than in others, and in checking up the findings hæmorrhage at the time of operation bore a direct relationship to the amount of adhesions formed. In some of the dogs the graft inserted was of greater diameter than the dog's sciatic, while in others the graft was of lesser size. At both ends of the graft in almost every instance a fibroneuroma would form. In some it was more marked at the proximal than at the distal end and in others the reverse. The size of the graft used bore no relationship to this phase. In one case it was impossible to determine from either gross or microscopical appearance where the graft was inserted so completely had it been incorporated in the tissues of the nerve itself. This dog had not regained function of the foot at the time it was sacrificed, but I believe would have produced a good result had the dog been allowed to live. In all of the other dogs the graft could be readily distinguished on gross appearance, although in many it was almost completely

surrounded by living connective tissue, yet there was enough of the dead graft left to identify it with the naked eye.

While we cannot agree with or even take seriously the bold conclusion drawn by Nageotte and Sencert that "we are in the right to say that not only the tissue which we have under our eyes is actually living, but that it is our dead graft itself which has become alive again"; but the statement "that we shall show how these dead heterogeneous nerve grafts are able to give functional results as good as autogenous grafts of equal long usage" seems the correct status. These men did not perform many operations and did not have the best of luck with some of their dogs. They drew their sweeping conclusions from only a few cases. In only one single instance of the experiments I have performed had the graft upon removal seemed alive, and in this instance the graft had been entirely replaced by new fibrous tissue. Even grossly it appeared in every other case to be dead. This is best noted grossly by removing it from the alcohol in which it had been placed and allowing it to become dry, when the dead portion becomes darker in color and loses entirely the glistening appearance of live tissue. Only those nerves which had been left in the dog for a long enough period for the graft to become wholly penetrated by the fibroblasts showed microscopically the appearance of live tissue. In but three instances did I find that the neuraxons grew primarily down through the graft; they usually were more abundant along the sides of the graft in the loose areolar and other surrounding connective tissue. The fibroneuroma which formed at the ends of the graft caused the production of much interlacing of the fibrillæ as they attempted to force their way through the scar. A longitudinal section through the whole graft and both ends of the nerve shows the fibrillæ parallel before entering the graft; then at the proximal end of the graft they are distorted as they try to penetrate the scar. After the graft is penetrated they again assume a parallel arrangement until they try to penetrate the distal scar, where the distortion or interlacing again is seen, but on entering the nerve proper the parallel arrangement is again assumed.

CONCLUSIONS

First. The alcoholized grafted nerve dies.

Second. A great amount of fibrous tissue forms at both the proximal and distal ends of the graft, and regenerating neuraxons finding it difficult to penetrate this mass become more or less interlaced in the attempt and some will pass out into the loose connective tissue which route they prefer to the graft, or may become lost in the adjoining structures.

Third. While excellent functional results were obtained in one dog and no doubt in others we would have obtained like good results had the dogs not been sacrificed early, yet the percentage of successes would have been very small and the histological findings do not justify the conclusion that the alcoholized nerve graft should be one of choice.

Fourth. The regenerative power of nerves is so great that good results may often obtain not because of any particular method used but in spite of it.

Fifth. The ideal nerve graft has yet to be demonstrated.

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ALCOHOL INJECTION IN ANGINA PECTORIS*

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This paper is in the nature of a report of progress in the work we are doing at the Massachusetts General Hospital in the treatment of angina pectoris by paravertebral alcohol injection. As yet we have not enough cases to permit us to form any hard and fast conclusions concerning the method, but even though the study is not yet completed I believe it should have a place in this symposium on the surgery of the sympathetic nervous system. Five cases have already been reported by Dr. James C. White and Dr. Paul Dudley White.[1] To this we add four treatments together with a report as to the present condition of the five original cases.

About two years ago we became much interested in Swetlow[2] and Mandl's[3] reports of the treatment of angina pectoris by paravertebral injection, particularly as one of us (J. C. White) had recently taken up the subject of paravertebral anæsthesia in surgery using the technic advocated by Labat. Dr. Paul Dudley White, the head of the cardiac clinic at the Massachusetts General Hospital, was also greatly interested and with his coöperation it was decided to try out this method on a group of the most severe cases of angina that presented themselves at the clinic. We felt that this method, if successful, offered certain very definite advantages over the operative treatment of this disease. This treatment is based on the theory that the pain of angina is transmitted through the rami communicantes to the spinal nerve roots and thence to the brain, and that the greater part of these painful sensations are transmitted through the upper dorsal roots.

Swetlow[2] believes that the somatic representation of anginal pain on the surface of the body indicates the roots through which these painful sensations pass. We will not discuss this theory as it already has been fully elaborated by Mandl and Swetlow. We feel that this sensory pathway in anginal pain is fairly well established and our aim is to interrupt this pathway, thus stopping the pain of the anginal attack. As the greater part of this sensory pathway is through the first five dorsal roots, we have generally been content to inject these five. We have not tried to pick out certain roots for injection by means of the somatic distribution of the pain on the body surface.

Such a procedure as this of course does not eliminate the cause of the pain whatever that may be.

The technic used by us has been very similar to that used by Swetlow and is based on that of Labat[4] for paravertebral anæsthesia. The patient

* Read before the American Surgical Association, May 1, 1928.

is placed on his side, the side to be injected uppermost. The back and neck are flexed and the spine kept level by a small pad under the short ribs and a pillow of the proper thickness. The skin is prepared with tincture of iodine which is washed off with alcohol. The seventh cervical and upper four dorsal spines are carefully located and marked on the skin with a small dot of acriflavin. Acriflavin used in this way after iodine gives a strong black mark which does not wash off easily.

A line is drawn with acriflavin 4 cm. from the spinous processes and parallel to them, and on this line crosses are made opposite each of the spinous processes previously marked. These crosses are the points of injection. Small dermal wheals are made with novocaine at each of these points. Five needles of a length of 8 to 10 cm. are used and are inserted as follows. The needle is inserted vertically to the skin of the back and pushed in until the rib is reached. The distance varies with the individual but is usually from 3 to 4 cm. Care must be taken not to go between the ribs and puncture the pleura. After the needle engages on the rib a little novocaine is injected and the needle is moved until it slips over the lower border of the rib. After the lower border is located the needle is withdrawn a few millimetres and its direction changed so that it points inward and toward the lower end of the spine at an angle of 45°. The needle is then advanced 2 cm. beyond the rib border. At this point it usually impinges on the vertebral body and should be correctly placed for injection. As its point is very close to the pleura the syringe is put on and aspiration attempted. If blood is drawn or a drop of pleural fluid the needle is withdrawn and reinserted. If not, 5 c.c. of 1 per cent. novocaine are cautiously injected. If the pleura has been injured this injection will cause coughing and the injection is stopped. The needle is left *in situ* and the next one is inserted. This is repeated until all five needles are placed and novocaine injected. Ten minutes is allowed to elapse. During this time a Horner's syndrome and anæsthesia of the skin of the chest wall will usually develop. Sometimes this will not take place. If there is no anæsthesia the result of the alcohol injection is somewhat doubtful. Five c.c. of 80 per cent. alcohol is next injected slowly through each needle. This injection usually causes some pain. If the pain is severe and increased by respiration, the injection through the needle should be stopped on account of the possibility of injury to the pleura. I think that I put a few drops of alcohol into the pleura in one case. The pain was very severe and markedly increased by respiration and for a short time I was much disturbed as to the outcome. It goes without saying that experience on the cadaver is of the greatest value. I do not believe that any one unless he has had a large experience in paravertebral anæsthesia should attempt alcohol injection in angina pectoris without experimental work on the cadaver.

Following injection there is a period of anæsthesia. As this wears off there may be a painful and annoying hyperæsthesia of the chest wall. In some of our cases this has lasted from 3 to 4 weeks. This in turn wears off and the patient is free from pain. If present the Horner's syndrome usually

persists for some time. There is usually a moderate rise in temperature lasting for 24 to 36 hours. Aside from one case in which there was severe pleural pain for a few hours, we have had no complications. The relief from the anginal attacks is immediate.

The five earlier injections were all done by Dr. James C. White and the work was taken up personally by me after his departure for Europe.

One of his patients who had been completely relieved of left-sided pain returned for relief of pain on the right side and he with three others complete the series.

All of these cases were carefully selected by Dr. Paul Dudley White as being the most severe or obstinate cases of angina pectoris coming to the clinic. None were refused on account of being too sick. All were totally unable to perform any kind of work, and several were having many attacks while at rest in bed. Several had had coronary thrombosis.

TABLE I.

Angina Pectoris.

Case	Side	Attacks at rest	Coronary occlusion	Relieved	Duration in months
1	Left	+	—	100 %	14
1	Right	—	—	0	1
2	Left	+	+	50+%	8*
3	Left	+	+	10+%	10
4	Left	+	—	100 %	9
5	Left	+	+	25 %	5*
6	Left	+	—	90 %	6
7	Right	+	—	65 %	1½
8	Left	+	+	..	..

TABLE II.

Angina Pectoris.

Treatments	9
Relief 90% or over	3
Relief 35%–90%	3
Relief less than 35%	2
Days in hospital	2–3
Deaths or serious complications	0
Post-op. hyperæsthesia and pain	7
Since died	2

In all eight patients have been treated. One had two injections on the same side; one had first one side injected and later the other. The rest have had one side injected.

Table I shows the type of case selected for injection though only in a very general way.

Injections were made for left-sided pain seven times and for right-sided pain twice. All but one were having angina pectoris while at rest. Three

* Patient has since died.

had had coronary occlusion and one had coronary occlusion six weeks after treatment. The rest of the table is summarized in Table II.

Table II shows the results obtained to date in the series. As will be seen the injection gave over 90 per cent. relief on the side injected in three cases and partial relief in three. One case was practically a failure (No. 3). The left side was injected in Case 1 only a month ago. He has had considerable pain and marked hyperæsthesia which he believes is cardiac in origin. He does not consider that he has been benefited by this last injection. This injection must be classed as a failure at the present time. Case 8 is completely relieved to date (two weeks) but the time is too short to put him down as a successful case. It will be noted that following seven of these nine treatments there was troublesome pain and hyperæsthesia. This persisted in some instances up to five weeks and some of the patients were much discouraged at first as this pain is not relieved by nitroglycerin. The first patient was kept in hospital two weeks for observation but the others have only remained two or three days.

The fact that there have been no deaths and no serious complications as a result of the injections seems to indicate that the procedure is a fairly safe one. The fact that two patients have since died is not surprising considering the type of case treated, particularly as the only result sought is relief of pain.

We have not gone far enough as yet to know the group or groups of cases to which this form of treatment is most applicable. So far we have found that angina pectoris may be relieved in cases with or without a history of coronary thrombosis. Swetlow, in a recent personal communication, states that he has added eight cases to his series and that relief was obtained in six, all of them patients with coronary disease. Two cases of painful rheumatic heart showed no improvement after injection.

Speaking now for myself alone—I have been intensely interested in the progress of this work which has been carried out under my eye but in which I took no active part until Dr. James C. White went abroad. I have felt in the past that operations on the sympathetic nervous system for the relief of angina pectoris were difficult, dangerous and somewhat uncertain. Here is a form of treatment which is not so difficult after one has mastered the technic. It gives promise of being distinctly less dangerous and of giving results as good if not better than sympathectomy.

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THE MORTALITY OF OPERATIONS UPON THE THYROID GLAND

WITH AN ANALYSIS OF 388 OPERATIONS PERFORMED DURING 1927

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THERE are few branches of surgery in which such prodigious strides have been made during recent years as in the operative treatment of diseases of the thyroid gland. Samuel D. Gross [1] in 1866 maintained that, even when the size of the thyroid gland threatened to suffocate the patient, no honest and sensible surgeon would ever think of removing it. Some of us can still remember the time when the mortality from operations on the thyroid gland was almost prohibitive. When we consider that the mortality has now been reduced to a fraction of 1 per cent., we have much cause for satisfaction with the progress in this particular branch of surgery.

Charles H. Mayo [2] states that the mortality from operations on the thyroid gland at the Mayo Clinic compares favorably with that from any other major operation. He gives the mortality when computed by operations as 0.95 per cent.; when computed by cases, 1.2 per cent. He describes six diseases of the thyroid gland as being amenable to surgical treatment; namely (1) diffuse colloid goitre, (2) adenoma without hyperthyroidism, (3) adenoma with hyperthyroidism, (4) exophthalmic goitre, (5) thyroiditis and (6) malignancy. In adenoma without hyperthyroidism, he gives the surgical risk as less than 0.5 per cent., with a prospect of cure in practically 100 per cent. In adenoma with hyperthroidism, Mayo gives the mortality as between 2 and 4 per cent., with a prospect of cure in 83 per cent. and marked improvement in another 5 per cent. In exophthalmic goitre he estimates the surgical mortality as 1 per cent.; in terms of cases, 1.74 per cent.

In an analysis of his cases five years after operation, Mayo found that 90 per cent. of his patients were living, 79 per cent. considered themselves cured or greatly improved by the operation, 8 per cent. were improved but still showed evidences of hyperthyroidism or its effects, and 3 per cent. were not benefited by the operation.

In a series of 1,954 goitre operations in the Mayo Clinic reported by Pemberton [3] in 1922, including 1,853 partial thyroidectomies, thirty-five patients died, a mortality of 1.78 per cent. The deaths were due to three main causes: namely (1) accidental causes, in three patients; (2) severe hyperthyroidism, in seven patients; and (3) moderate hyperthyroidism plus pulmonary complications due to lowered resistance, in twelve patients. Pemberton stressed the importance of a proper selection of cases for operation. If poorer surgical risks are accepted, a higher mortality rate is unavoidable.

In a later communication Pemberton [4] pointed out that the mortality rate following surgical procedures on patients with exophthalmic goitre has been reduced to 1 per cent. in terms of operations and 1.73 per cent. in terms of patients. In his experience, patients with visceral degenerative changes form the largest part of the mortality list in the surgery of exophthalmic goitre. When the patient comes from operation early in the disease, before degenerative changes have taken place, the operative risk is much less and the likelihood of cure proportionately greater. Pemberton attaches great importance to painstaking attention to details as a means of preventing post-operative complications in cases of exophthalmic goitre.

According to Pemberton,[5] there were 1,928 operations upon 1,725 patients with goitre at the Mayo Clinic during 1924. Ten patients died, giving a mortality of 0.51 per cent. by operation and 0.58 by case. There were no deaths in the group of 677 patients who had goitres unassociated with hyperthyroidism; in 368 patients with hyperfunctioning adenomatous goitre, there were four deaths (1.08 per cent.); in 741 with exophthalmic goitre, six deaths (0.8 per cent.). Pemberton rightly ascribes the extremely low mortality rate achieved by the present-day surgical treatment of diseases of the thyroid gland to the perfection of operative technic and the discovery of means of controlling crises of hyperthyroidism.

Other Mortality Statistics.—While the statistics of the clinics which have devoted much time and attention to goitre work are naturally the most favorable, there has been a commendable fall in the mortality rates of experienced surgeons everywhere who are doing a large number of goitre operations.

Dowd[6] in 1924 reported the end results of 150 operations for goitre. Five patients died in the hospital and four more since leaving the hospital. One hundred and three enjoyed good health and were able to do an ordinary amount of work. Dowd observed so many failures from röntgen-ray and medicinal treatment that he believes surgery to be the best treatment for a large proportion of patients with goitre.

In a series of 923 operations for goitre, Joyce[7] in 1926 reported twenty-two deaths, a mortality of 2.3 per cent. The series included 851 thyroidectomies with a mortality of 1.9 per cent., and seventy-two ligations with a mortality of 7 per cent. For resections in exophthalmic goitre the mortality was 2.4 per cent.; in toxic adenoma, 1.8 per cent.

Clute[8] has emphasized the part that the pre-operative use of iodine solution may play in the surgical treatment. Before using iodine solution, he operated upon only 38 per cent. of his patients in one stage; after employing this measure, upon 63.7 per cent.

In a series of 2,200 operations for simple goitre, de Quervain[9] in 1924 reported a mortality of 0.84 per cent. In 1,682 operations upon patients under forty, there was only one death. As would be expected, the mortality rose with the age. In the fifth decade, it was 1 per cent.; in the sixth, 4.1 per cent.; in the seventh, almost 20 per cent.; and in patients over seventy, 25 per cent.

In forty-six operative cases of goitre reported by de Planque[10] in 1924, there were four deaths. Only half of the thyroid gland was removed in each case. Only seven of the seventeen patients with exophthalmic goitre and nineteen of the twenty-nine with non-toxic goitres were cured by the operation. De Planque has now adopted subtotal thyroidectomy as a routine procedure.

Sandelin[11] in 1925 reported a series of 268 thyroidectomies with five deaths. In his work he did a bilateral one-stage thyroidectomy under ether. He did not ligate the inferior thyroid artery, thus saving time and avoiding the risk of injury to the recurrent laryngeal nerve and the parathyroid bodies.

Prat[12] in 1925 described thirty-four cases in which partial thyroidectomy was performed for exophthalmic goitre. Commenting on the low death rate, he maintained that physicians should no longer cling to medical treatment if there is no manifest improvement. Almost 80 per cent. of his patients were complètely or nearly cured by the operation.

Troell[13] in 1925 reported seven deaths in connection with the thyroid operation under general anæsthesia in a series of fifty-six cases of toxic goitre. The anæsthesia may have been partially responsible for this relatively high mortality.

During the year 1927, 936 patients with goitres presented themselves at the DeCourcy Clinic or the out-patient goitre department of the Good Samaritan Hospital, 388 of whom submitted to operation. Cases in which there were hyperplastic or adenomatous goitres constituted the great majority

of the operative group. In 92 per cent. of the operative cases, the goitre was in a toxic state. For the most part, the patients who were not subjected to operation were adolescent girls with colloid goitres. However, the surgical group included, in addition to hyperplastic (exophthalmic) and adenomatous goitres, colloid goitres in persons past twenty-one who did not progress favorably after three months of medical treatment, malignant growths and thyroiditis. During this entire series of operations there were no ligations; both lobes of the thyroid gland were removed in every instance.

Preparation for Operation.—In the colloid cases very little preparation was required and the average stay in the hospital was only four days. Preparation for operation in the case of adenomata depended on the degree of toxicity and cardiac instability. In mildly toxic cases there was no special preparation. In severely toxic adenomatous goitres with cardiac instability or decompensation the patients were placed in bed in the hospital and given a course of digitalis therapy. If there was neither irregularity of the heart beat nor decompensation, three doses of a standardized tincture of digitalis of 30 minims each were given at intervals of eight hours. The purpose of this preparation was to furnish the heart with enough assistance to enable it to withstand the reaction following operation. When cardiac arrhythmia was present with or without decompensation, ten drops of tincture of digitalis were given three times a day until compensation was restored. This result generally required from five to seven days. As a rule the digitalis was discontinued about five days before operation but resumed immediately afterward. When there was any considerable instability of the heart, it was given in the form of one ampoule of digifoline every four hours, beginning immediately after the operation. In a few cases, the arrhythmia did not cease in spite of the preliminary digitalization; yet thyroidectomy was performed and the cardiac irregularity in no way interfered with the operative result.

Elsewhere I [14] have referred to the fact that the most important presage of circulatory failure in exophthalmic goitre is the beginning of cardiac irregularities. In this condition, it will be recalled, the vascular changes are similar to those of aortic regurgitation, although less in degree. It is for this reason that I believe that the preparation for operation should include a most careful check-up on the condition of the heart and digitalization whenever cardiac irregularities are found or appear likely to develop. I agree with Richter [15] that cardiac decompensation and auricular fibrillation may cause delay but do not really constitute a contraindication to surgery. To quote Richter, "Nothing is to be hoped for in such cases in the presence of continuous thyrotoxicosis; nothing in surgery is more brilliant than their recovery after adequate thyroidectomy."

Use of Lugol's Solution.—In cases of hyperplastic and adenomatous goitre I have adopted the routine practice of using Lugol's solution both before and after operation. While iodine gives only temporary benefit in toxic goitre, it possesses the very great advantage of allowing the surgeon

to operate exactly at the time when the patient is enjoying a remission from his disease, as it were. And I believe that it is to this type of preparation and a careful technic involving the absolue minimum of surgical trauma that the low mortality rates encountered in the larger surgical clinics during the last few years are due.

In an earlier communication I [16] offered an explanation for the temporary benefit following the use of Lugol's solution in cases of toxic goitre. During the course of my work on hyperplastic goitres in patients subjected to preliminary iodine treatment I have repeatedly observed that the gland at operation is extremely œdematous. When it is sectioned, water exudes freely from the cut surfaces. In patients who have not received Lugol's solution preparatory to operation, on the contrary, this condition is not observed.

The foregoing observations have led me to believe that the beneficial influence of Lugol's solution in cases of toxic goitre is brought about by a rapid formation of colloid material in the iodine-famished gland, the result of which is a back pressure on the secretory cells and thin-walled veins surrounding the acini. This condition causes passive œdema, as a result of which the cells, temporarily rendered inactive, fail to absorb the toxic substance. That is the probable reason why the clinical condition of the patient improves. Eventually, however, new blood vessels are formed in response to the changed conditions. Then absorption is resumed and the goitre again becomes toxic. This theory would also serve to explain why improvement is slower and less noticeable in long-standing cases, since a deposition of fibrous connective tissue around the acini prevents them from becoming overdistended with colloid material.

My practice in cases of hyperplastic and adenomatous goitre has been to administer ten drops of Lugol's solution three times a day for from two to four weeks, depending upon the degree of clinical improvement and the change in the gland itself, as checked by metabolic readings. Improvement following the administration of Lugol's solution is not uniform. In early untreated cases, although many of them were very severe, the results of iodine medication were excellent and dependable. In cases of long standing, on the contrary, the action of Lugol's solution was not so satisfactory. The effects upon the gland itself were less noticeable, improvement was much slower, and the ultimate therapeutic results were in no way comparable with those observed in cases of shorter duration. When Lugol's solution had previously been given but toxic symptoms had returned after a temporary remission, it was frequently found that the symptoms abated and the metabolic rate fell on a régime of complete rest with iodine medication.

In uncomplicated and non-toxic cases, patients under iodine medication were not put to bed but encouraged to keep up and about. One patient whom I saw in consultation with another surgeon began to improve immediately she was allowed out of bed. Particularly noticeable was the improvement in her appetite.

In all toxic cases after operation I give about 30 minims of Lugol's solution, as required, usually repeating the dose in about eight hours. In severe cases of exophthalmic goitre, a third dose may be required; but this is seldom the case when the patient has been prepared properly.

Advantages of Open Wound.—In toxic cases showing evidence of myocardial instability it was our policy to allow the wound to remain open for forty-eight hours. This procedure, it was found, diminishes the reaction and consequently lessens the strain placed upon the heart. For example, in cases of severely toxic adenomatous goitre in which our past experience would lead us ordinarily to expect a post-operative temperature of 103° F., we generally observed a temperature between 100° and 101°—sometimes below 100°—when the wound was allowed to remain open for forty-eight hours after operation. I feel that this is a factor of material importance in avoiding a considerable percentage of post-operative deaths.

Complications.—In this entire series of 388 operations, 92 per cent. of them upon patients with toxic goitre, there was but one death. This makes our mortality for the year 1927 only .0025 per cent., a notable improvement over the statistics of several years ago.

Our only death occurred in a patient with exophthalmic goitre, who received preparation with Lugol's solution and was apparently in good condition at the time of operation, when the metabolic rate was plus 19. Beginning eight hours after the operation, there was a severe reaction. The temperature rose to 107° F. and the pulse was so rapid that it could not be counted. Ice packs failed to check the reaction and death took place fourteen hours after operation. In this case Lugol's solution was not used post-operatively. Whether or not its prompt use after the operation would have prevented the fatal issue we cannot say.

In six of our cases the goitrous condition was complicated by diabetes mellitus. All of these patients had hyperplastic goitres, and they were prepared for operation with the routine Lugol's solution, plus insulin and a restricted carbohydrate diet until their urine became sugar-free. In these cases operation was performed without difficulty and convalescence was uneventful. Even when insulin was withdrawn and greater liberality in the diet allowed, glycosuria did not return. Of course, the diabetic condition was probably still present; but the removal of the hyperplastic thyroid gland had undoubtedly effected an improvement in the tolerance for sugar.

CONCLUSIONS

1. During recent years there has been a notable drop in the mortality from operations on the thyroid gland, a procedure which once resulted in a prohibitive death rate. The mortality is now held to be only about 1 per cent.

2. At the DeCourcy Clinic there were 388 operations on the thyroid gland during 1927, with only one death, a mortality rate of only .0025 per cent.

3. The most important factors in bringing about the lower mortality

from goitre operations have been improved surgical technic and the more careful pre-operative and post-operative care of the patient, particularly the use of Lugol's solution and digitalis.

4. When the operative wound is allowed to remain open for forty-eight hours, the likelihood of high post-operative fever is greatly diminished.

5. Patients with diabetes mellitus, when properly prepared, may be subjected to thyroidectomy without danger, and usually with considerable benefit.

6. Lugol's solution brings about a remission from the symptoms of exophthalmic goitre, probably by causing great œdema of the thyroid gland, due to distention of the acini with colloid material. This œdema presumably interferes with the absorption of toxic substances from the gland.

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PERFORATION OF PEPTIC ULCER*

OBSERVATION OF ONE HUNDRED CASES AT THE PENNSYLVANIA AND PRESBYTERIAN HOSPITALS

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Acute perforation of peptic ulcer has presented a problem of interest to surgeons for many years, and in view of the already voluminous literature on the subject, it is with a feeling somewhat of temerity that we present this paper, especially as we fully appreciate that it contains nothing new.

With the thought that it might be of interest to review those treated at the Pennsylvania and Presbyterian hospitals in recent years, we have examined the records of sixty-six cases at the former, from 1910 to 1928; and thirty-four at the latter, from 1920 to 1928, each having been operated upon and the diagnosis of perforation confirmed.

During this period there were admitted to the Pennsylvania Hospital 637 cases, and to the Presbyterian Hospital 243, a total of 880, in which the diagnosis of peptic ulcer was made.

For the privilege of reporting this series I am indebted to Doctors Gibbon and Mitchell, at the Pennsylvania; and Doctors Jopson, Hodge and Speese, at the Presbyterian; and the former chiefs at both institutions, upon whose services the cases were admitted.

Operation for perforation usually requiring emergency treatment, the vast majority were performed by the members of the junior staffs who handle such cases. This fact should be borne in mind in discussing the operative procedure adopted. The results are, therefore, fairly representative of what may be expected in two such general hospitals.

Two patients were under twenty years of age (Table I), twenty-six were

Table I

Table Showing Age of Patients

Under 20	20–29	30–39	40–49	50–59	Over 60	Not stated
2	26	27	17	17	7	4

between twenty and thirty, twenty-seven between thirty and forty, from which time the incidence decreased, seven being over sixty years of age.

We were rather surprised at the preponderance of the condition in males, it having occurred only five times in women. This is in accord with other observers, the proportion of males, however, being somewhat higher than in many of the recorded series.

* Read before the Philadelphia Academy of Surgery, November 5, 1928.

Just why the colored race should have a considerably lower percentage of perforation is not clear, only ten cases having been encountered.

A discussion of the etiology of peptic ulcers and their perforations would lead one far afield and is not within the scope of this paper, nor is it our intention to dwell, except very briefly, on the question of symptomatology and differential diagnosis. Those interested in these aspects of the subject are referred to the many excellent articles dealing therewith. Sufficient to say that abdominal pain, either upper or generalized, with or without vomiting, was recorded as the chief complaint ninety-five times, and one patient had symptoms confined to the region of the left kidney. Six gave a history of hæmatemesis, two had melina, and two noted both symptoms in addition to the abdominal pain.

About one-half of the entire group had been for various periods under more or less irregular medical observation for "stomach trouble", and of these, only eight had regarded themselves as being improved, and none, as cured of their complaint.

In making a differential diagnosis, among the conditions most frequently encountered, one must consider the possibility of acute appendicitis; acute cholecystitis (with or without stone); acute pancreatitis; thoracic infections; mesenteric embolus; tabetic crises; volvulus; intestinal obstruction, and other less frequently encountered conditions. A mistaken diagnosis of acute appendicitis was made seven times; acute cholecystitis five times; intestinal obstruction in three, and acute pancreatitis in two instances.

The fact that all cases of acute perforation do not present acute symptoms was exemplified by a colored man, of thirty-five years, who was admitted to the Pennsylvania Hospital complaining of moderate abdominal pain. He had been having occasional attacks of indigestion for the preceding four years, and on the day of admission had a rather severe exacerbation of his previous symptoms. On admission he showed a pulse rate of eighty-four and sub-normal temperature, lay quietly in bed, was not shocked, and while there was some upper abdominal tenderness, there was no marked rigidity. He was seen by one of the junior members of the staff and held for observation. Next day the tenderness had increased somewhat, there was moderate abdominal rigidity, peristalsis was audible but sluggish, and the liver dulness was not obliterated. Exploration was advised on the strength of his history and physical signs and revealed a perforated callous duodenal ulcer, with widespread fluid in his abdomen. A simple closure and drainage was done and he made an uninterrupted recovery.

In this connection it was noted that on admission (Table II) sixty-four patients were in a condition of shock and presented a rigid abdomen; twenty-two had rigidity without shock; two were in a condition of shock but had no rigidity, and in five the notes state that they presented neither shock nor rigidity.

A colored man of thirty-five years was treated in the medical wards and discharged at the end of twenty-eight days, the diagnosis being abdominal

angina. He was readmitted three weeks later with symptoms of a perforation and immediate exploration revealed a perforation of a callous gastric ulcer with his abdomen full of gastric contents. He died.

TABLE II
Table Showing Condition of Patients on Admission

Shock and rigid	Not shock—rigid	Shock—not rigid	Not shock—not rigid	Not stated
64	22	2	5	7

These observations merely stress the importance of being on the lookout for cases presenting atypical symptoms.

In 79 per cent. of the cases, the pre-operative diagnosis of perforated ulcer was correct, but this of course does not take into consideration those instances where exploration revealed such a pre-operative diagnosis to have been wrong. This percentage is lower than that reported by Brenner [1]—91 per cent. correct diagnosis in twenty-four acute cases. We believe, however, that the important factor is the recognition of the fact that the patient has an acute abdomen requiring immediate exploration, and that one should not delay operation in an endeavor to make a correct diagnosis.

Very little need be said about the importance of early surgery in cases of acute perforation. In this series, of fifty-four cases seen within twelve hours, fourteen died (Table III), a mortality of 28 per cent., 27 per cent. in Stenbuck's [2] series of fifty-three. Fourteen patients were operated upon between twelve and twenty-four hours, eight of whom died, a mortality of 57 per cent. One patient with a history of perforation six days previous to operation, and another of seven days' duration, each lived, exploration revealing a partially walled off localization of the perforation.

In thirteen instances the patients gave a definite history of prodromal symptoms previous to perforation, as evidence by a marked increase of their former trouble. Eight of these cases died. Table III shows the duration of chronic symptoms, and it is of interest to note that in ten instances the patients were sure that they had been free of symptoms previous to the time of their perforation. Four patients had previously had an appendectomy and two had been operated upon for peptic ulcer, one of the latter being a perforation.

Anæsthesia.—Nitrous oxide-oxygen, usually with sufficient ether for relaxation, was the anæsthetic of choice in the vast majority of instances. It is our personal feeling that in these cases, this combination, when properly administered, more nearly approaches the ideal than any other method. Many of the operations, starting as local, end with a general anæsthetic, and we feel that the time spent in administration of local measures is therefore largely wasted. Frequently these patients are poor surgical risks and operative speed is a prime requisite. Muscular relaxation being one of the important factors

TABLE III

Table Showing Duration of Acute and Chronic Symptoms before Operation, with Outcome

Duration of acute symptoms before operation		Chronic symptoms																					
			Weeks				Months									Years							
		None	1	2	3	4	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	Over 5	Not stated	Total
Under 12 hrs.	L.*	7	5	1	1	1	2	1			2		1				2	3	4	5	2	10	4	51
	D.†	2	1		2												2	1	1			4	1	14
12 to 24	L.			1									1					1		1		1	1	6
	D.			1					1									1	3	1		1		8
24 to 36	L.																					1		1
	D.						1				1									1		1		4
36 to 48	L.		1										1										1	3
	D.	1																				1		2
2½ Days	L.																							
	D.	1																						1
3 Days	L.												1											1
	D.																							
4 Days	L.				1												1							2
	D.																							
5 Days	L.																						1	1
	D.																							
6 Days	L.																	1						1
	D.																							
7 Days	L.		1																					1
	D.																							
Over	L.																							
	D.				1																			1

* L.—Lived.
† D.—Died.

in this connection, it has been our experience that this can be most satisfactorily obtained by the use of nitrous oxide-oxygen.

The chief objection to a general anæsthetic is of course pulmonary complications. Six patients developed pneumonia and died.

We fully realize that many surgeons condemn any form of general narcosis in these cases, and if they or their assistants are adept in the use of para-vertebral, intraspinal or other methods of administration, they have all the more reason for favoring their use. It has, however, been our experience in general major abdominal operations, using one or a combination of the various forms of local anæsthesia, that pulmonary complications are by no means avoided. We feel, therefore, that unless one has had extensive experience in the use of local methods, it is usually better for both surgeon and patient to use a general anæsthetic when dealing with acute peptic perforations.

We are in accord with the majority of surgeons who have written on the subject that the diagnosis of perforation is an indication for immediate operation regardless of the patient's condition. Four cases, however, not included in this series, with histories and signs typical of perforation, were so near death on admission that it was evident operation *per se* would be fatal. With the exception of these fatalities, all other cases were explored soon after the diagnosis of perforation was made.

Operative Procedure.—One of the moot points which will probably never receive unanimous support, is whether operative measures should be limited to merely closing the perforation, with or without excision of the ulcer, or whether a gastro-enterostomy should be added, there being very few writers as yet who advocate a partial gastrectomy at this stage.

Should one be fortunate enough to explore a duodenal or pyloric ulcer within a few hours preceding its perforation, the patient being in good condition, we believe that few surgeons would be content with merely local treatment of the ulcer. From their recorded observations most operators prefer, in addition to some form of excision, cautery puncture or simple invagination, a gastro-enterostomy, pyloroplasty or other procedure. It therefore seems illogical to us that the mere fact of the ulcer having perforated should so change the underlying pathology as to render unnecessary any measure other than simple excision or closure, providing, of course, that the patient's condition is such as to warrant a gastro-enterostomy or pyloroplasty being done.

A colored man of twenty-eight years, who stated that he had always suffered from indigestion, was operated upon five years previously for a perforated appendix. Two years later he had a simple closure done for a perforated duodenal ulcer, and he had relief for the next three years till the day of admission. At this time he made his own diagnosis of perforation, and exploration revealed a partially walled off perforation in the centre of an old duodenal ulcer. The ulcer was closed and a posterior gastro-enterostomy was done. On the nineteenth post-operative day pus was aspirated from the

* L.—Lived.
† D.—Died.

eighth costal interspace posterior axillary line; his abdominal condition apparently cleared up but he gradually sank and died on the twenty-fifth post-operative day.

A comparison of the mortality of those cases in which gastro-enterostomy was not done (seventy-two cases with twenty-five deaths—39 per cent.) with those in which this method was adopted (twenty-eight cases with eight deaths—29 per cent.) is of little value, for it fails to take into consideration the condition of the patient at the time of operation. In the latter group, in which gastro-enterostomy was done, pneumonia and myocarditis were each responsible for one fatality and peritonitis for the remainder. The extra time required for adding the gastro-enterostomy apparently did not influence the outcome (Table IV), and we feel that this argument cannot be used against its adoption.

TABLE IV

*Table Showing Duration and Type of Operation with Outcome**

	Minutes								Hours							
	20		30		45		60		1¼		1½		1¾		Over	
	L.†	D.‡	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.
Simple closure	5	5	14	9	12	7	6	3	4			2	1			
Closure plus gastro-enterostomy					2	1	2	1	9	2	2	1	4		1	

* 7 cases not stated as to time.
† L.—Lived.
‡ D.—Died.

Judging from the follow-up records of other writers, excellent results have been obtained when the simpler method was used, and we regret exceedingly that the follow-up systems at the Pennsylvania and Presbyterian hospitals did not enable us to reach a sufficient number of these patients to make their recording worth while. We realize that this omission in itself greatly vitiates the value of our observations, but, in spite of this failure, we are of the opinion that if the patient's condition warrants it, and the technical difficulties are not a contraindication, closure of the perforation, or excision and closure, plus posterior gastro-enterostomy is the method of choice.

When it can be done we feel that the appendix should be removed coincident with the treatment of the perforation, and this seems all the more important when it is so situated, from adhesions or otherwise, that its removal adds somewhat to the technical difficulties.

Drainage.—Where it was noted that the perforation was either walled off from the general peritoneal cavity, or the latter was not grossly contaminated —twenty cases—drainage was omitted seven times with two deaths, each from peritonitis. In those cases, eighty in number, in which the peritoneum was widely involved, after removing as much as possible of the contaminat-

ing material, the abdomen was closed without drainage eight times. Two in this group of eight died.

While it may not always be necessary to institute drainage following a perforation, depending upon the extent and type of involvement of the peritoneal cavity, yet we have never seen any ill result which could be attributed to its use. We prefer a cigarette drain placed in the pelvis, through a separate stab wound in the lower abdomen, and should peritonitis not occur it can be removed at the end of forty-eight hours. The recollection of a few instances is still quite vivid in which drainage was not considered necessary but was done, and subsequent developments made us very thankful that this procedure had been adopted. In the great majority of cases the drain was removed on or before the end of the second day, which fact tends in itself to prove that it was not necessary.

Complications.—Peritonitis, either local or widespread, was, of course, present to a variable degree in each case but was not recorded as such unless it persisted and gave rise to symptoms beyond the second post-operative day. Twenty-four patients developing this complication died, while eighteen survived. Table V shows how frequently this condition was encountered in the various types of ulcer; whether or not the abdomen was drained; the type of operation done; whether or not the perforation was walled off, and the mortality in each group.

Subphrenic abscess as such, giving rise to symptoms several days after operation, was only encountered once. A white man of fifty-one years, with a twelve-hour perforation of a duodenal ulcer which had been giving rise to symptoms for two weeks previously, had a simple closure and drainage operation done, peritonitis being widespread. On the twenty-second post-operative day laparotomy was again done for intestinal obstruction—small bowel to hepatic colon. On the thirty-third day following the original operation symptoms of intestinal obstruction again developed, and at operation, in attempting to free the adhesions, the small bowel was twice ruptured and closed. On the sixty-fourth post-operative day he developed a subphrenic abscess which was later opened and drained and he made a good recovery. A collection in the subphrenic region may of course have existed in those cases dying of peritonitis, but if so, it was not recognized as such. Whether or not this low incidence of subphrenic abscess was due to the fact that only in very few instances was the upper abdomen drained, as advanced by Mills [3] we do not know.

Two patients developed empyema subsequent to pneumonia. Two patients eviscerated a large part of their intestinal tracts following violent coughing attacks, one of them having a gastric hæmorrhage in addition. We cite these latter cases as a plea for the use of strong catgut in closing the peritoneal cavity, especially when the latter is infected.

There was a mortality of 33 per cent. for the series as a whole (46 per cent. Dunbar,[4] 31 per cent. Stenbuck,[2] 27 per cent. Mills,[3] 18.6 per cent. Gibson [5]).

TABLE V

Table Showing Whether Perforation Was Walled Off from Abdominal Cavity; Type of Operation; Whether Drainage Was Used; Whether Peritonitis Developed and Outcome of Case

Location of Ulcer	Perforation walled off																Perforation not walled off (free)													
	Simple closure								Closure and gastro-enterostomy								Simple closure								Closure and gastro-enterostomy					
	Drain				Not drained				Drain				Not drained				Drain				Not drained				Drain				Not drained		
	‡ Peri't later		Not peri't later		Peri't later		Not peri't later		Peri't later		Not peri't later		Peri't later		Not peri't later		Peri't later		Not Peri't later		Peri't later		Not peri't later		Peri't later		Not peri't later		Peri't later		Not peri't later	
	*L.	†D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D.	L.	D
Duodenal	1	2	2				1		1		1	1			2		6	3	15			1	2		2	3	3	2			3	
Pyloric		1	1												1		1	3	1	1							3				
Gastric			2	1	1										1	1	5	11	8	2			1		1		2				1
Total	1	3	5	1	1		1		1		1	1			4	1	12	17	24	3		1	3		3	3	8	2			3	1

* L.—Lived
† D.—Died
‡ Peri't—Peritonitis

Table VI shows the interval between operation and death, with causes for the same. The greatest mortality occurred within the first twelve post-operative hours and was ascribed to peritonitis with its associated shock.

TABLE VI

Interval Between Operation and Death, with Cause of Same

	Hours		Days														
	Under 12	12–24	2	3	4	5	6	7	8	9	10	11	12	13	14	Over	Total
Peritonitis			1	2	1	1	1										6
Shock and Peritonitis	8		3														11
Peritonitis and Pneumonia				1	1				1								3
Peritonitis, Pneumonia and Empyema																1	1
Peritonitis and Evisceration													1			1	2
Peritonitis and Alcoholism				1													1
Pneumonia					1	1	1					1					4
Lung abscess															1		1
Post-operative hæmorrhage															1		1
Cardiac—Toxemia							1									2	3

The pulmonary fatalities appeared from the fourth to the sixth day, while the abscess complications were manifest after the second week. This agrees in the main with Stenbuck's observation except that peritonitis falls in an earlier period.

CONCLUSIONS

This series is of course too small to warrant any conclusions of value, and, as was stated at the outset, nothing new has been presented. Our impressions from a study of the group are:

1. Operation should be performed as soon as possible in all cases in which the diagnosis of perforated ulcer has been made, unless the patient is obviously in a moribund condition. Should exploration show that an incorrect diagnosis has been made, the condition revealed will in nearly all cases be one which would have required urgent surgical interference.

2. Nitrous oxide-oxygen is the anæsthetic of choice unless the surgeon has a strong preference for some form of local administration.

3. If the patient's condition warrants it and the operator's technic is proficient, closure, excision or cauterization of the ulcer, plus gastro-enterostomy or pyloroplasty, is the method of choice, this however being an open question.

4. It is safest to institute drainage of the lower abdomen for forty-eight hours in all except definitely walled-off perforations.

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MESENTERIC INJURIES AND INTESTINAL VIABILITY

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In penetrating wounds of the abdomen, injury to the mesentery is one of the most common and serious lesions encountered. Hæmorrhage itself may be fatal from injured mesenteric vessels; slits in the mesentery lead to hernia; but aside from this what especially should be emphasized is that mesenteric injuries are of importance in proportion to the extent to which the integrity of the blood supply to a given intestinal loop is compromised. So that a mesenteric injury cannot be considered as a clinical entity but as an intestinal injury as well.

In addition to injuries resulting from trauma of the mesentery, we have also to consider the surgical removal of cysts and tumors of the mesentery, as their removal may affect the viability of an intestinal loop. Therefore in dealing surgically with traumatic injuries and new growths of the mesentery, it is necessary to arrive at a rather definite conclusion as to how much of the blood supply can be sacrificed and yet leave the affected loop viable. Failure to resect a loop of intestine incapable of regaining its vitality would be disastrous, while doing unnecessarily a resection would also give a tremendous increase in mortality, especially in traumatic injuries, as other organs are frequently injured at the same time, making such a case a very poor surgical risk. So that in a border-line case severely shocked it would probably be better not to do a resection.

Warbasse[1] says wounds parallel to the bowel, if they cross one or two large vessels, require resection of the bowel, and that simple suture of wounds of the mesentery is not much called for because wounds large enough to require suturing are apt to have done so much damage to the vessels as to demand more radical treatment.

Da Costa[2] says if branches of the superior mesenteric artery are divided near the bowel, gangrene of the bowel will result, but wounds of a branch far from the intestine do not cause gangrene. If the wound is found close to the gut, the portion of the gut supplied by the cut vessel should be resected.

Fowler[3] says that if more than an inch or so of mesentery is torn from an intestine, a resection should be done.

Surgical teaching would seem to fix a mesenteric tear of about two inches at its intestinal attachment as being the border line; that is, greater lengths would require resection while shorter lengths would only require suturing.

The clinical cases herewith reported, supplemented by some experimental work that I have since done, would tend to show that a much more extensive sacrifice of the blood supply can be tolerated without the necessity of a resection.

EXPERIMENTAL WORK

CASE I.—White man, age thirty-six, was shot in the abdomen with a thirty-eight-calibre pistol and was admitted to the hospital in a marked state of shock with severe abdominal pain and with general board-like rigidity. A laparotomy was done within three hours of the accident. There was a large quantity of blood in the abdomen. Nine perforations were found, two in the transverse colon and seven in the small intestine. The perforations were closed in the usual way. The bullet ranged along the mesenteric attachment, severing the blood supply to an intestinal loop, for four inches. The bleeding vessels were ligated and the mesentery sutured to the intestine. The omentum was then tucked around this intestinal loop and tacked. No resection was done. A drain was put in. Patient made a good recovery and is now in good health, five years after operation.

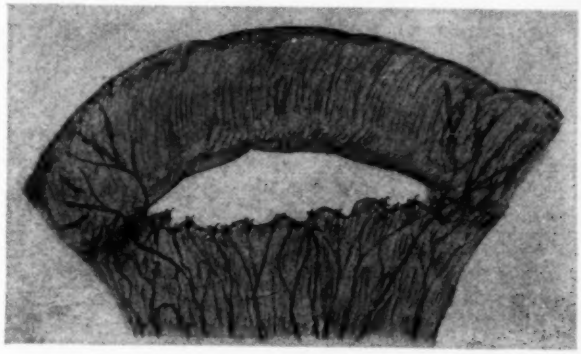

FIG. 1.—Drawing shows mesentery separated from intestinal loop with vessels tied off, illustrating condition in clinical cases dealt with; also as produced in experimental cases.

CASE II.—White man, age sixty-six, dairyman; was severely gored by a bull July 28, 1921. The abdomen was torn open and a number of coils of small intestine were dragged and forced out of the abdomen. The man was then wallowed about in the farmyard before he could be rescued. A large bath towel was pinned around him to support the extruded intestinal loops, and the patient was taken to St. Peter's Hospital, where I first saw him

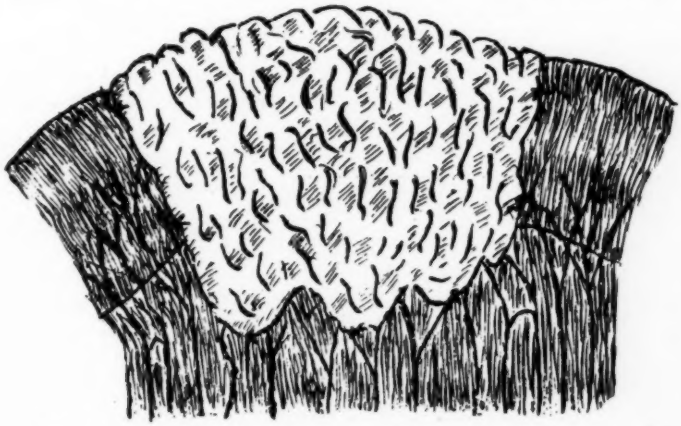

FIG. 2.—The mesentery has been sutured back to the intestine and the omentum tucked around the damaged loop and tacked in position as was done in the clinical and experimental cases.

several hours after the accident. He was in a marked state of shock, with coils of intestine still outside and there was hæmorrhage from the wound. Treatment to combat shock was immediately instituted, followed by operation. There was a large irregular wound three and one-half by five inches through the right rectus muscle about the level of the umbilicus. This wound was excised and enlarged, whereupon the abdomen was found to have a large quantity of free blood. Hæmorrhage was still in progress from torn mesenteric vessels. The horn had passed through the base of the mesentery and

ranged upward along the aorta, stripping off the peritoneum and loosening the head of the pancreas and duodenum. The mesentery was torn loose from the small intestine at its attachment at two different points, one for a distance of three inches and the other for eight inches. After ligating the bleeding vessels (Fig. 1) the mesentery was sutured to the intestine, and the omentum tucked around the long damaged loop and tacked in position. (Fig. 2.) Owing to the general condition of the patient a resection was not done. For several days following the operation the patient remained in a serious condition but gradually improved. There was slight drainage from the wound for about ten days. Aside from this the man made an uneventful recovery and left the hospital in about three weeks, and is now in good health, seven years after operation.

CASE III.—Woman, age thirty-eight, had tumor mass completely filling the pelvis, which could be palpated above pubes. This was at first thought to be an ovarian cyst. At operation it proved to be a large mesenteric blood cyst. It was attached close to the intestine and in its removal the blood supply to the intestinal loop was apparently sacrificed for three and one-half inches. The omentum was tacked around the loop and over the raw mesentery. Patient made a good recovery, and is now in good health three and one-half years after operation.

Dog No. 1.—Was operated on March 2, 1923. Six inches of mesentery was ligated and cut away from the intestine, severing all blood supply. (Fig. 1.) The mesentery was then sutured to the intestine to close the opening and omentum was tacked around the damaged loop. (Fig. 2.) The dog made a good recovery. Three months later the dog was again operated on to explore the result. It was found that omentum was densely adherent to the intestinal loop and exceedingly vascular.

Dog No. 2.—Was operated on March 5, 1923. Eight inches of mesentery was ligated and separated and treated as in dog No. 1. This dog made a good recovery and got away two weeks after operation.

Dog No. 3.—Was operated on March 12, 1923. I meant to separate the mesentery for about ten inches, but when the vessels were tied and the mesentery severed I found that thirteen inches had been separated. This dog at first vomited more than the others but apparently made a good recovery, and was able to take all kinds of food. Five weeks after the operation the dog was found dead in the morning without any signs of having been sick the day previous, having taken food well, and was as playful as usual. Unfortunately, I was out of town attending the state meeting and did not get to autopsy this dog. After five weeks of normal health it does not seem plausible to assume that this dog died from a failure of this intestinal loop to regain its vitality. This dog was pregnant at the time of operation which might have been a factor. All these dogs were fed all kinds of food, including bones.

COMMENT

At this stage of the clinical and experimental work I am unable to say where these long loops of intestine, freed from their mesenteric blood supply, got sufficient nourishment to survive. The mesenteric vessels near the intestine are said to be terminal and do not anastomose in the intestinal coats. It does not seem plausible that simple suturing of detached mesentery with its ligated vessels back to the intestine would establish blood supply sufficiently early to save the damaged loop. Therefore it would appear that wrapping the omentum around the intestine and suturing it in position (Fig. 1) hastens the formation of plastic adhesions about the loop, thus facilitating the reëstablishment of the blood supply. On exploring one of the dogs two months after operation the omentum, mesentery, and the intestine itself were found to be

very vascular at this area. Aside from the scientific and clinical interest, the important practical point is that a long loop so treated does survive, making a resection unnecessary. I am not prepared to say that it would always be safe to ignore a loop of intestine separated from its mesentery from eight to ten inches as the clinical and experimental work might tend to show. However, in border-line cases already severely shocked, I am of the opinion that it would be safer not to do a resection, certainly, where no more than four or five inches are separated, which is about twice the previously recognized border line. More conservative surgical treatment promises the better result.

If one would look over records of resections in different hospitals and work done by different operators it would be found that the results would be far from satisfactory. I am unable to say whether this is due to a faulty technic or to the pathology dealt with. Probably both are factors, but I should say the traumatic or pathologic condition for which a resection is usually done is often a very grave condition itself, and when the shock of a resection is superimposed the mortality will be much higher.

I recall that early in the war the mortality from intra-abdominal injuries was so high in the British Military Hospitals that a commission was sent out to investigate it. It was decided that too many resections were being done, and they sent out a bulletin urging that resections be avoided wherever possible and that simple closures of intestinal injuries be done instead, even though it caused considerable narrowing and angulation of the intestine. Following this the results were better and the mortality reduced. Therefore it is desirable, in dealing with mesenteric and intestinal injuries, to resect only in the presence of urgent indications.

CONCLUSIONS

1. This limited clinical and experimental work would tend to show that a much more extensive sacrifice of the blood supply to an intestinal loop can be tolerated than has heretofore been taught and practiced.

2. It necessarily follows that the number of intestinal resections can be materially reduced with a reduction of mortality, shortening of convalescence and increase in number of complete recoveries.

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THE INTERPRETATION OF CHOLECYSTOGRAPHIC FINDINGS*

OPERATIVE CHECK IN TWO HUNDRED AND SEVENTY-SEVEN CASES

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of Battle Creek, Mich.

As surgeon in an institution dealing with a large number of patients suffering from gall-bladder disease, it has been the privilege of the essayist to devote considerable time in the last three and a half years to the development of cholecystography. It is the purpose of this paper to summarize the practical results of this test in a series of more than 2,000 patients suspected of gall-bladder disease, and the operative check on nearly 300 of these patients from our surgical service. In practically all of the borderline cases, Dr. A. S. Warthin's opinion was obtained on the pathological findings, and even in some of the cases showing gross disease the specimen was referred to him for study.

Cholecystography has achieved such popularity and wide use in connection with gall-bladder surgery, it is unnecessary to devote much space to the brief but eventful history of this valuable test. We should not fail to express our debt of gratitude to Graham, Cole, Copher and Sherwood Moore for their devotion to the problem of visualizing the gall-bladder.

Röntgenologic interest in the gall-bladder began with the work of Carl Beck, of New York, who in 1900[1] reported several cases of gall-stones discovered with the X-rays, including one notable instance of gall-stones on the left side in a case of *situs inversus,* all confirmed by operation. No studied effort was made to discover gall-stones röntgenologically in a routine manner until our first published paper on this subject in 1913[2] and the paper by L. G. Cole,[3] prepared simultaneously but published a few months later. Pfahler[4] and Haenisch[5] at the 1910 meeting of the American Röntgen-Ray Society reported several cases, and at that same meeting we displayed in the scientific exhibit seven röntgenograms of gall-stones *in vivo,* several of them stereoscopic. A. Beclere,[6] of Paris, in 1910, discussed the radiologic differentiation between urinary and biliary calculi, and H. Beclere,[7] of Paris, the following year, published a monograph on radiology of the liver with special reference to hepatic abscess. Since then numerous publications on gall-bladder röntgenology have appeared—too numerous to mention. Reference should be made to Knox,[8] Thurstan-Holland,[9] George and Gerber,[10] Caldwell,[11] Kirklin[12] and Carman[13] for special prominence in contributions to the subject.

However, in spite of painstaking analysis of methods and correlations of mechanical and clinical findings, it was evident that röntgenology could not furnish reliable help in more than 30 to 40 per cent. of cases; and the dis-

* Read before the Western Surgical Association, December 9, 1927.

tressing lack of help was most apparent in the very cases where it was most needed. Up to the time of Graham's first announcement (February, 1924) the only really reliable direct evidence of gall-bladder disease was the demonstration of stones containing enough lime to cast a röntgen shadow.

As indirect evidence, a number of signs had been advanced, including (a) an inconstant deformity of the duodenal bulb, (b) a gall-bladder impression in the duodenum, (c) evidence of adhesions involving the duodenum beyond the duodenal bulb (duodenitis), (d) spasmodic manifestations in the stomach, (e) hepatofixation of the stomach, and (f) visualization of the gall-bladder itself.

Some of these signs have proven to be of considerable worth, especially "hepatofixation of the stomach", "midgastric spasm", and "adhesions about the duodenum beyond the bulb", although the duodenal adhesions beyond the bulb are in our opinion more suggestive of periduodenitis than of a gall-bladder lesion.

The "gall-bladder impression" has been seriously objected to as a sign of gall-bladder disease for the simple reason that in the light of our present knowledge, based on the Graham test, we recognize that the gall-bladder is by no means usually responsible for this impression; and even if it were, there is no proof that the gall-bladder needs to be pathological to cause such an impression. There are often present lobes of the liver about the size and shape of the gall-bladder, which could easily make this impression. Furthermore, in many of these cases where the so-called gall-bladder impression was present, we found by cholecystography that the gall-bladder was located elsewhere and did not coincide with the seat of the crescentic duodenal deformity.

The "inconstant deformity of the duodenal bulb" may be due to a great many things. It is true the deformed duodenal bulb is sometimes found in gall-bladder disease, but it is also found in connection with a number of other lesions, *e.g.*, highly nervous states, spastic stage of tabes, hyperthyroidism, appendicitis and in periduodenitis.

The "visualized gall-bladder" (without the introduction of dye) has been impeached as a sign of gall-bladder disease for at least two very important reasons: Even though the gall-bladder shadow is visualized, we have no reason to believe that this visualization indicates the presence of disease. Furthermore, there is grave reason to doubt the gall-bladder identity of the shadow which has been supposed to represent the visualized gall-bladder. It was supposed that any ovoid shadow in the right upper quadrant corresponding approximately in shape and size to the gall-bladder was the gall-bladder, especially if in addition to this shadow one could definitely identify the inferior border of the liver and the outline of the right kidney. In some instances, indeed, reports went out basing a diagnosis of cholelithiasis (cholesterin stone) upon a filling defect occupying roughly the centre of this ovoid shadow. We now know that in a great many instances this ovoid shadow mistaken for the visualized gall-bladder was in reality caused by the

duodenum in some instances, and the pyloric end of the stomach in others, or by a combination of the two. The filling defect in the shadow was nothing but a bolus of air imprisoned in the duodenum. This is easily demonstrated in Figure 1, which shows such a rounded area of density containing air, which undoubtedly represents a cross-section of the duodenal bulb,

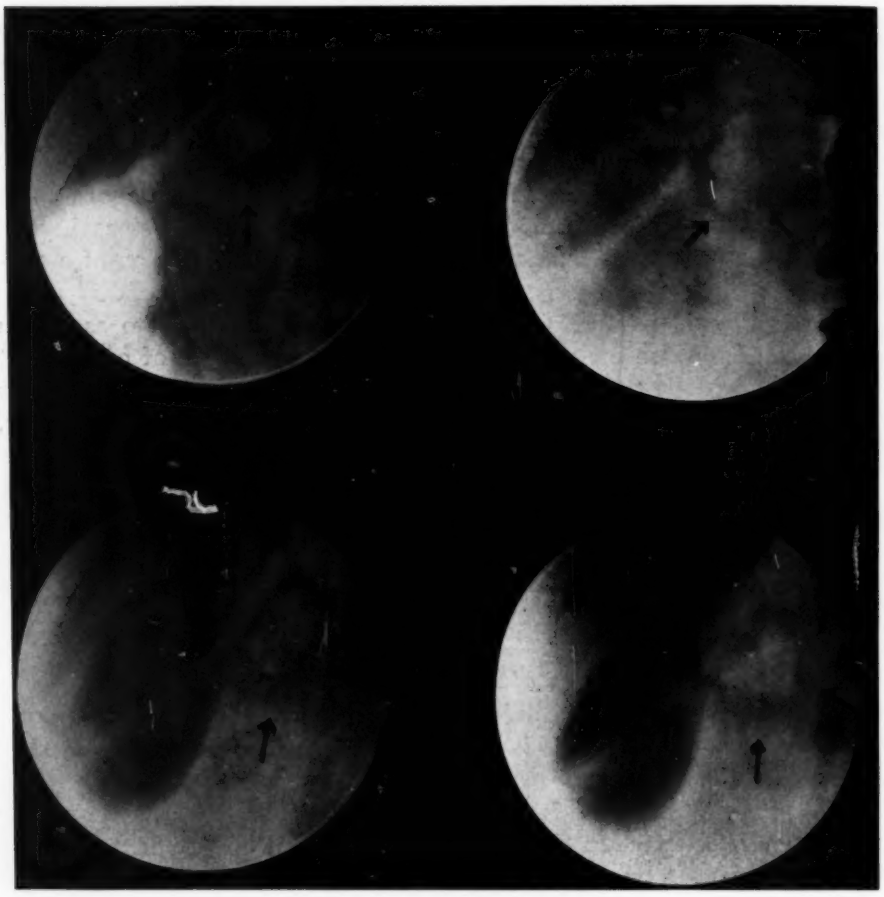

FIG. 1.—Four illustrations from the same case showing in the two upper circles, marked by arrows, the rounded shadow of the duodenum seen in profile, containing gas; in the lower two circles the same rounded shadow seen in relation to the gall-bladder visualized by cholecystography.

with air arrested therein. Figure 2 is an anatomical drawing illustrating the posterior direction taken by the duodenal bulb and the upper part of the second portion of the duodenum. It makes plain that the shadow of the duodenal wall is for a considerable distance seen in profile, thus giving most favorable conditions for casting an ovoid shadow, ofttimes imprisoning a small quantity of gas. Cholecystography permits us to demonstrate that this visualized shadow is not due to the gall-bladder, for in hundreds of cases after the introduction of the dye the gall-bladder is seen lying to the outer side of this suspected ovoid density. Indeed, we sometimes see a deformity of the gall-

bladder evidently due to the duodenum; so that it is just as proper to speak of a duodenal impression on the gall-bladder as of a gall-bladder impression on the duodenum.

Thanks to the Graham test, we are now able to very greatly expand the usefulness of the röntgen examination in gall-bladder disease.

Author's Technic.—We prefer the intravenous method, although occasionally the dye is given by mouth. The intravenous injection of the dye is made in the late afternoon (4:00 to 5:30) and the first röntgenograms are made at 8:00 A.M. the following day. The first films having been approved, the patient then eats a breakfast containing as much fat as possible and at 12:00 NOON returns to the X-ray department for further röntgenograms. In special cases, the study is pursued for a longer time.

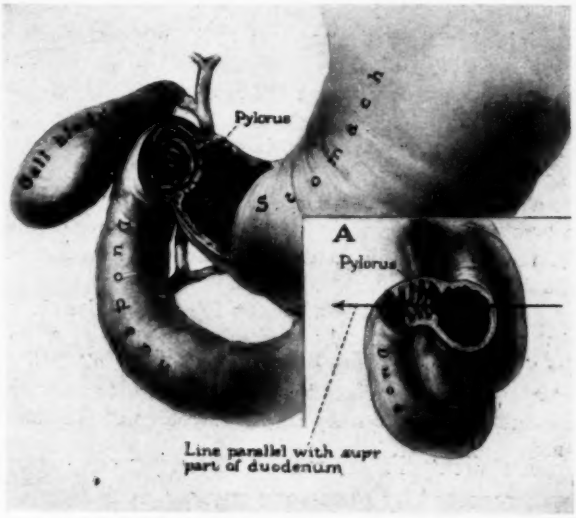

FIG. 2.—An anatomical drawing illustrating the posterior direction taken by the duodenal bulb and the upper part of the second portion of the duodenum. Note how the shadow of the duodenal wall is for a considerable distance seen in profile, thus giving most favorable conditions for casting an ovoid shadow, ofttimes imprisoning a small quantity of gas.

Our early experiences with tetrabromophenolphthalein were somewhat unsatisfactory, owing to the vascular depression following the injection of this bromine compound, which was sometimes so marked as to cause the patient and his friends a great deal of alarm. In our experience with approximately one hundred injections of the bromine salt we had no case which gave us any alarm, although sometimes there was a very disconcerting temporary drop in the blood pressure. With the iodine compound, however, our injections have not been followed in any case by serious blood-pressure drop and the percentage of reactions following the injection has been very small. In the tetrabromophenolphthalein cases we were able to avoid the vascular depression by the concomitant use of adrenalin. With tetraiodophenolphthalein, less than 10 per cent. of our patients suffer any unpleasant reactions which they mention the next morning.

The patient appears at the office at four or five in the afternoon and lies down on a couch or table with the left arm extended upon an arm board; the bend of the elbow is sterilized with one-third-strength tincture of iodine in alcohol. Sterilized towels are placed about the arm and a tourniquet of rubber tubing put on the arm with forceps, just tight enough to distend the veins but not to cut off the pulse. The patient clenches his fist, thus tensing the muscles of the forearm and distending the veins. A hypodermic needle, 18-gauge, attached to a glass hypodermic syringe, is thrust into one of the prominent veins in the bend of the elbow, and just sufficient blood withdrawn to make sure that the needle is securely within the lumen of the vessel. The hypodermic syringe is then twisted loose from the needle and the end of a rubber tube, previously made ready and attached to a burette filled with warm Ringer's solution, is attached to the needle, and the tourniquet released, thus starting at once the flow of warm Ringer's solution into the vein. We use an ordinary burette of 150 to 200 c.c. capacity such as was formerly employed for salvarsan work. As soon as the flow of Ringer's solution is estab-

lished, the nurse pours into the burette the solution of tetraiodophenolphthalein already prepared * and this, diluted by the addition of 75 to 100 c.c. of warm Ringer's solution, is allowed to flow into the vein. The injection proceeds as rapidly as the gravity method permits, four or five minutes being sufficient for the injection. The dye is followed up at once by 15 or 20 c.c. of clear Ringer's solution to wash out the needle and the vein, after which the needle is withdrawn. The patient is then caused to lie down for fifteen minutes. The evening meal may be taken, but the patient is asked to confine the diet to carbohydrates (fruits, fruit juices, sugar, rice, potatoes, lemonade) excluding fats and proteins. The patient is usually requested to go home and go to bed for the evening. If the patient has been on a milk diet, the test is likely to be inaccurate.

At eight o'clock the next morning, before breakfast, fourteen or fifteen hours after the injection, the patient appears at the röntgen department, at which time two 20 by 24 centimetre films of the gall-bladder region are exposed. These are developed at once to make sure that they are technically satisfactory. The patient is then allowed to go to his breakfast, eating whatever is pleasing but including in the breakfast milk or cream and an egg yolk. It is our custom to let the patient return at twelve o'clock for two more films. We thus have four films, two made at the fourteenth hour before breakfast and two at the eighteenth hour, approximately three and a half hours after a breakfast containing fats. By the foregoing technic the patient is permitted to follow his usual program in the day, any discomfort or disagreeable symptoms having occurred the evening before.

In favor of the late afternoon injection is the observation familiar to every surgeon that a gall-bladder fistula flows much more freely at night than in the daytime. Indeed for this reason some surgeons recommend that all their cholecystomized patients be given regular feedings during the night in order to maintain a maximum flow of bile into the intestines and to minimize the discharge of bile through the fistula.

Excellent clinical results following employment of the oral method have been reported by numerous authors, including Menees,[14] who first suggested the oral administration, Stewart,[15] Carman,[16] and others; but we have preferred the intravenous method for various reasons, some of which appear later.

There are reactions which follow both the oral and the intravenous administration of the dye. Digestive upsets, such as headache, vomiting, nausea and purging occasionally follow the oral administration; similar reactions are noted following the intravenous administration except that diarrhœa is a very rare complaint. It is interesting to note that patients who develop urticaria following intravenous cholecystography complain of being subject to urticaria; those who have headaches usually have put down headaches as one of their subjective complaints for the relief of which they came to the institution; those who suffer an asthmatic attack are subject to asthma.

In over two thousand intravenous administrations we have had only one reaction which gave us alarm, that of an elderly physician who became unconscious fifteen minutes after the injection of the dye, but who the next morning felt perfectly all right. Advanced cardio-renal disease is

* Three and one-half grams of Mallinckrodt's tetraiodophenolphthalein are dissolved in 25 or 30 c.c. of properly sterilized Ringer's solution, and boiled in a water bath for fifteen minutes.

probably a definite contraindication to the intravenous Graham test. There have been a few instances of phlebitis, not over 1 per cent. of the cases, and in only one instance was the trouble in the arm of serious consequence. This occurred in a patient with cardiorenal disease who had suffered amputation of both breasts. Entry into a vein was secured only with difficulty and in spite of carefully washing the vein with Ringer's solution after the dye had been introduced, a phlebitis developed which gave trouble for some months. We have not observed any abscess formation in the arm. When difficulty is encountered in finding a suitable vein in the bend of the elbow, we have occasionally utilized a vein on the dorsum of the hand.

Ordinarily the only reaction experienced by patients following the intravenous method is a vaso-dilatation, notably a flushing of the face, appearing while the injection is still proceeding, which is followed almost immediately by a pallor of short duration. The patient mentions that he can feel his heart pounding. We keep our subjects recumbent for fifteen minutes following the injection, after which time they are allowed to go on about their business. Very rarely does the patient the next morning recall any inconveniences which he cares to mention. Certain races especially susceptible to emotional influences seem to be predisposed to a reaction. The writer recalls particularly one patient who exclaimed, "There, I knew I would have a reaction," before we had even introduced the needle. Another patient fainted after the needle had been introduced but before any Ringer's solution or dye had had time to enter the vein.

Let me state once more that the average patient complains of no discomfort whatever and those who do complain usually suffer nothing more than a species of malaise which is gone within an hour. We rarely find it necessary to use adrenalin. Those who suffer discomfort are told to take some hot water with bicarbonate of soda. I, myself, after taking the injection, immediately got up from the table and proceeded with the remaining two hours of my afternoon's work, attended a medical society meeting that night and did my usual list of operations the next morning without any discomfort whatever. Two of my assistants had a similar experience.

The intravenous method has the very great advantage over the oral in that a definite dose of the dye has been positively introduced into the blood stream, there being no question of failure of capsules to dissolve, incomplete absorption of dye, etc.; under these conditions failure to obtain a gall-bladder shadow and a faint shadow density are therefore very significant and to be definitely interpreted. In looking over the summaries of cases of several authors who have used the oral method, it is evident that in a considerable proportion of their Graham tests there is no basis afforded for an interpretation. For instance, in a series of one hundred cases reported by one author, in twenty-eight there was no gall-bladder shadow, in thirteen the examination was unsatisfactory and in eleven the capsules failed to dissolve, making at the lowest count 28 per cent., and at the highest 52 per cent., of the cases in which he had no right to express any opinion at all; whereas with the

intravenous method one is justified in giving an opinion in practically 100 per cent. of the cases.

A word further with reference to reactions: In the year 1926, 831 Graham tests were given in our service by the intravenous method. No reactions at all were reported in 577 cases. Reactions varying from vomiting to a slight feeling of weakness were reported by 254 cases. In these 254 cases vomiting was reported in twenty-eight; shortness of breath and a tightness of the chest in thirteen; urticaria in ten; diarrhœa in nine; and a sore arm in two cases. Of the urticaria cases three were subject to urticaria. In the cases reporting shortness of breath several were subject to asthmatic attacks. We thus had sixty-two cases out of 831, or 7.5 per cent., reporting disturbing reactions, surely not a great figure compared with the frequent digestive reactions following the oral administration of the dye.

In reporting on cholecystographic examinations we have devised the following terminology:

Stone Positive.—If gall-stones contain enough lime to cast positive shadows, the Graham test is quite unnecessary except as a means of identifying certain densities which may not clearly represent gall-stones. One has to exclude renal stone, calcified mesenteric glands and islands of calcium deposit in the right lower rib margin. Stones containing no lime or too little lime to cast positive shadows are recognized with the Graham test as negative areas in the gall-bladder shadow. Gas in the colon and especially gas in the duodenum may cause considerable confusion in the interpretation of negative areas lying within the gall-bladder outline. It is especially important in such cases to repeat the X-ray films after the patient has been given cleansing enemas. In making these renewed studies the tube should be tilted in such a manner as to throw the gall-bladder shadow into a different relation to the shadow of the colon or spine. A faint gall-bladder shadow overlying the spine might be easily overlooked. Gas retained in the duodenal bulb may on account of the natural contours of the collapsed duodenum greatly resemble the faceted appearance of negative stone shadows. Sacculations of the gall-bladder caused by pericholecystic bands, especially when these adhesions occur about the gall-bladder neck, may cause error by retaining small "puddles" of dye after the gall-bladder has been otherwise emptied. A papilloma or other tumor on the skin lying next to the film may cast a shadow sufficiently dense to cause confusion. Tyson[17] has reported a case of metastatic hypernephroma within the gall-bladder which quite likely would have led to a diagnosis of gall-stone if the case had been submitted to cholecystography.

Up to this date (November 15, 1927) there have come to operation in the writer's surgical service seventy-seven patients in whom a pre-operative Graham test report of "stone positive" had been made. There were three errors, one due to sacculation of the gall-bladder; the other two due to calcareous deposits in the gall-bladder wall. In the case due to sacculation there were pericholecystic bands practically dividing the gall-bladder into

three sacs, and as the gall-bladder emptied two of these sacculations retained a sufficient amount of dye to make us suspect the presence of gall-stones. This was one of our early cases, encountered while we were still harboring the idea that gall-stones sometimes imbibe such an amount of the opaque matter that previously non-opaque stones might become somewhat opaque. We now know that this is not the case. Experiments made by soaking gall-stones for many hours in a solution of tetraiodophenolphthalein have shown that the gall-stones do not imbibe any of the dye. The following table sets forth our results in this series.

TABLE I "STONE POSITIVE".

Total cases operated	77
Stones found at operation	74
Errors	3
Error 3.9 per cent. Reliability 96.1 per cent.	
Errors in first series of 46 cases	3
Errors, second series of 31 cases	0

Absence of Shadow.—Failure to discover a gall-bladder shadow following the administration of the Graham test, especially when the dye has been given intravenously, constitutes the most convincing reliable and important evidence of disease of the biliary tract. Normally the dye-containing bile passes freely from the common duct into the gall-bladder, where it attains a concentration so pronounced that the gall-bladder shadow clearly shows in the röntgenogram. This concentration of the gall-bladder bile has been variously estimated as being four to ten times more dense than the common duct bile. When, after careful study, we fail to perceive the gall-bladder shadow, we are then convinced that one or more of a number of causes have been operative to prevent visualization of the gall-bladder. The following may be mentioned as the most important causes, an effort being made to list them in the order of their probability:

1. Cystic duct obstruction. This may be due to a stone impacted in the cystic duct or in the neck of the gall-bladder; or, less frequently, kinking or other form of obstruction of the common duct due to adhesions, infiltration of malignant disease in the neighborhood, or pressure of an extra-biliary tumor.

2. The gall-bladder may be filled with stones and the gall-bladder mucosa damaged to such an extent that the concentrating function is interfered with.

3. Failure of the concentrating function in a stone free gall-bladder, the failure being due to disease of the gall-bladder wall, interfering with the glandular activity.

4. Stones or other obstruction of the common duct. Because the gall-bladder is not able to empty itself, there does not occur the normal interchange between the dye-containing bile and the bile which is free from dye. The result is an absence of gall-bladder shadow.

5. Organic disease of the pancreas or liver or both, such as carcinoma, hepatic cysts or abscesses, or advanced hepatitis.

6. Failure of patient to follow instructions not to eat fat until a certain period has elapsed after the injection. It is possible to completely nullify the value of the Graham test by either the oral or the intravenous method if the patient does not adhere strictly to instructions regarding a carbohydrate evening meal. We were surprised to find one of our young patients with relatively slight clinical indications of gall-bladder disease showing an absence of gall-bladder shadow. Careful inquiry into the case elicited the confession that he had eaten three bromose tablets four hours after the injection. We therefore repeated his Graham test, thinking that these tablets, which are rich in vegetable oils, might have caused evacuation of the gall-bladder, and found a normal response to the test. We therefore repeated the test experimentally on several normal subjects and found in all of them that the taking of two or more bromose tablets four hours after the injection of the dye prevented visualization of the gall-bladder. We have also found it difficult to visualize the gall-bladder of patients on a milk diet. Therefore in all cases in which we have a report "absence of shadow" we carefully interrogate the patient with reference to dietetic faults contrary to instructions, believing that these dietetic faults explain the few errors which we have encountered in checking up our results on "absence of shadow" reports.

TABLE II. "ABSENCE OF SHADOW".

Total number of cases operated	79
Stones found present (73.4 per cent.)	58
No stones found (26.6 per cent.)	21
Errors (normal at operation) (2.5 per cent.)	2
Reliability in finding gross disease of biliary tract (97.5 per cent.)	

An analysis of the twenty-one noncalculous cases where "absence of shadow" was reported is given in the following table:

TABLE III. "ABSENCE OF SHADOW".

Total cases checked at operation	79
Gall-stones present	58
No stones found in	21
In these twenty-one cases, the diagnosis was as follows:	
Carcinoma of pancreas or common duct	5
Abscess of liver	1
Cirrhosis of liver	2
Chronic pericholecystitis, adhesions especially about gall-bladder neck	5
Papillomatous gall-bladder	1
Chronic cholecystitis, fibrosis of walls, thick, black, tarry bile	5
Cause of absence of shadow not apparent, normal bile being found in gall-bladder	2
	21

The two failures to visualize the gall-bladder referred to in the last line of the above table were evidently cases of error. Interrogation of the patients led us to believe that the error was due to failure to follow out dietetic instructions.

"Absence of shadow", therefore, signifies gross disease of the biliary tract with only 2.5 per cent. probability of error. In 73.4 per cent. of cases stones were found at operation; in 87.3 per cent. of cases gross disease, either stones or other pathology, in the gall-bladder itself; in 10.1 per cent. gross disease of the biliary system outside of the gall-bladder.

Cases of jaundice almost invariably give "absence of shadow" and we no longer give the Graham test in cases of definite jaundice.

In seventeen cases where an "absence of shadow" was reported, the test was repeated by the intravenous method. In fifteen it had been given in the first place by vein, in two orally. The "absence of shadow" was confirmed in thirteen cases. The two which had been tested previously by the oral method were found to be normal by the intravenous method. One showed an insufficient density. In the light of our experimental observations, the three cases which were normal on repeat were probably cases of failure to observe dietetic restrictions after the first test.

Normal.—Normal Graham tests were reported when the gall-bladder outline appeared at the fourteenth hour with normal contours, normal uniform density and normal emptying; that is, having nearly, if not completely, evacuated the dye within three hours following the ingestion of a breakfast containing fat (breakfast of patient's choice, including, however, the yolk of two eggs or a glass of half milk and half cream, preferably both).

In checking the results of cases reported "normal" which have come to operation, we have been guided by the following surgical criteria: (1) Presence of gall-stones. (2) Presence of pericholecystitis. (3) Enlargement of the sentinel gland of Lund. (4) Opacity or thickening of gall-bladder walls. (5) Hepatitis, especially localized in the gall-bladder region.

Up to November 15, 1927, there had come to operation in our surgical service at the Battle Creek Sanitarium thirty-six cases in which a pre-operative Graham test report had been given as "normal".

The following table represents our operative findings on these thirty-six cases:

TABLE IV. "NORMAL".

Cases checked at operation, gall-bladders	36
Palpated but not removed	11
Palpated, inspected, not removed	15
	26
Gall-bladder removed	10
Of these, Dr. A. S. Warthin reported,	
As normal	7
As pathological	3

In none of these thirty-six cases was stone found.

The reliability of the "normal" report for the exclusion of stone in the gall-bladder was 100 per cent. There is some discussion forthcoming on its reliability toward excluding noncalculous disease. Some will object that in the gall-bladders not removed there might have been disease demonstrable only on removing the organ and referring it for microscopic study. The ten gall-bladders in this series removed by cholecystectomy were referred to Dr. A. S. Warthin, who reported seven as normal and three as definitely pathological, but in none of them was the pathology of an advanced grade. Therefore, on the basis of the cases actually removed and examined microscopically, the normal report is worth 70 per cent. toward excluding gall-bladder disease; but judging by the commonly accepted surgical criteria of noncalculous disease of the gall-bladder we were able to exclude gall-bladder disease in twenty-six further cases of this series. It is thus evident that for excluding gall-bladder disease, even that shown microscopically, this test was worth 70 per cent. based upon ten cases, but for excluding gross disease of the gall-bladder, based on thirty-six cases, the test was worth 83.4 per cent. After all, at the operating table, the surgeon usually depends upon the macroscopic appearance.

The pathological reports (A. S. Warthin) on the ten cholecystectomies in this series with a pre-operative Graham test of "normal" are listed as follows:

183–947 Normal gall-bladder.
184–976 Normal gall-bladder.
171–259 Normal gall-bladder.
180–042 "Slight catarrhal inflammation. Practically normal. Why did you remove it?"
186–523 "Very slight catarrhal cholecystitis. Practically normal."
189–424 "Practically normal. Slight catarrhal cholecystitis."
185–511 "Practically normal. Very slight fibrosis."
181–504 Typical strawberry gall-bladder.
198–362 Papillomatous gall-bladder.
170–726 Strawberry gall-bladder.

Very important in this analysis of the cases with "normal" report which came to operation is the fact that no stones were found in any of them. Furthermore, it is evident from the perusal of Doctor Warthin's reports that in only three cases of the ten was the pathology of any consequence, and in these it was of the type called "strawberry" gall-bladder, of the importance of which as a surgical indication a great many internists have not yet been convinced.

Pathological Noncalculous.—This classification includes those cases where no stones are recognized but the gall-bladder shadow is imperfect as to one or more of the following items: Form, density or evacuation. Irregularities of form may be due to pressure from without, as, for instance, the duodenal impression above mentioned, the pressure of an enlarged liver, or of a tumor of the head of the pancreas, or of enlarged glands. An abnormality of form may also follow operation. It may be taken as a fact that

after cholecystostomy adhesions of the gall-bladder are a constant finding. When the density of the gall-bladder is faint, provided the test is given by the intravenous method, we may conclude that the concentrating function of the gall-bladder is imperfect. Our experience shows that these cases are usually to be classified as chronic catarrhal cholecystitis, usually of the so-called strawberry type. When the gall-bladder shadow is very faint, it is manifestly impossible to estimate the emptying time, but occasionally we find gall-bladder shadows of normal density which become even more dense at the eighteenth hour and do not disappear for three or four days. These are manifestly cases of abnormal emptying and the significance may be important. The following tabulation shows our findings in eighty-five such cases checked at operation.

TABLE V. "PATHOLOGICAL, NONCALCULOUS".

Total number of cases checked at operation	85	
Found pathological gall-bladder in	71	
Normal gall-bladder on palpation and inspection	14	
Value of test in finding diseased gall-bladder	83.6	per cent.
Number of cases in this series, stones found at operation	6	
Value of report toward exclusion of gall-stones	93	per cent.

Again, we may be criticized for leaving fourteen of these gall-bladders in place, since our judgment is based upon macroscopic rather than microscopic findings; but if so, the error here will be offset by the error in the normal group. The surgeon at operation must depend upon palpation and inspection plus the history to guide him in deciding whether or not to remove the gall-bladder. Our practice is to do cholecystectomy or else leave the gall-bladder alone, except in those relatively infrequent cases where cholecystostomy is a life-saving procedure.

It will be noted that in the above table there were six cases showing stone at operation. In all these cases the stones were small, in several of them one single small stone, the size of a rice kernel. If we had not tried to exclude cholelithiasis in this group, our accuracy would have been greater than the 83.6 per cent. reported.

Value of the Graham Test in Cholelithiasis.—We have in this series of 277 cases a total of 121 reported "noncalculous". Table VI sets forth the reports following Graham's test on these 121 cases.

TABLE VI. VALUE OF GRAHAM TEST TOWARD EXCLUDING CHOLELITHIASIS.

Total cases reported "noncalculous"	121	
Of these, the Graham test report was		
"Normal" in	36	
"Pathology, noncalculous" in	85	
At operation, stones were found in	6	
Error 4.8 per cent.	Reliability 95.2 per cent.	

In other words, the "normal" or "pathological, noncalculous" report, as described in this paper, almost certainly excludes stone in the gall-bladder, the error being less than 5 per cent. It is of special interest to note that no

stones were found in any of the thirty-six cases reported "normal". Unless the test is given by the intravenous method, the second and largest group of this series, the "pathological, noncalculous", could not be included; for by the oral method variations in density of the gall-bladder shadow would be worth too little to mention.

Toward the confirmation of a diagnosis of cholelithiasis, we also have some valuable data, based upon 138 cases of this series where the operated gall-bladder contained gall-stones as shown in Table VII.

TABLE VII. VALUE OF GRAHAM TEST TOWARD THE DIAGNOSIS OF CHOLELITHIASIS.

Total number of operated cases with stones	138
Of these cases, the Graham test report was	
"Absence of shadow" in	58
"Stone positive" in	74
"Pathological, noncalculous" in	6
"Normal" in	0
Error 4.3 per cent.	Reliability 95.7 per cent.

This tabulation shows that with an error of less than 5 per cent. we were able to report either a "stone positive" or "absence of shadow" (in 75 per cent. of "absence of shadow" cases, gall-stones are present) in 132 out of 138 cases.

The Present Value of the X-ray in the Diagnosis of Gall-stones.—The Graham test when positive for stone is worth 96 per cent.; when negative for stone, it is worth 95 per cent. Our experience shows that in 95 per cent. of the cases of cholelithiasis, one at least of the following positive X-ray signs should be present:

1. Stones visible by direct X-ray examination without resorting to the Graham test (such stones contain lime sufficient to make positive shadows).

2. Stones visible by negative areas in the cholecystographic shadow.

3. Failure of the gall-bladder to visualize after the Graham test by the intravenous method.

SUMMARY

Summarizing the entire 277 cases which represented our personal operative experience on Graham tested patients up to November 15, 1927, we have the following table with an average of correct reports in 90 per cent. of the cases.

TABLE VIII. GENERAL VALUE OF GRAHAM TEST—OPERATIVE CHECK. November 15, 1927.

Graham Test Report	Cases	Error	Correct
"Stone positive"	77	3	96.1 per cent.
"Absence of shadow"	79	2	97.5 per cent.
"Pathological, noncalculous"	85	14	83.6 per cent.
"Normal"	36	7	83.4 per cent.
Total	277	26	90 per cent.

Not for one moment would we suggest dependence upon the Graham test to the exclusion of other findings. We feel that a carefully taken history is of the greatest value in these cases, and careful attention should be given to the physical findings and other laboratory reports. It is evident that the Graham test affords us very great help, so great indeed that no surgeon should attempt to do without its aid.

The test also has a useful place in differentiating right upper quadrant shadows. We sometimes find in the right upper quadrant localized densities, evidently due to lime deposits, which lack the characteristic appearance of gall-stones. Graham's test will often be quite sufficient to identify these shadows without the necessity of subjecting the patient to the more distressing pyelography. We recall several cases in which combined pyelography and cholecystography was done, proving that certain shadows were located neither in the kidney nor in the gall-bladder.

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RELIEF OF OBSTRUCTIVE JAUNDICE FROM TUMORS IN THE HEAD OF THE PANCREAS*

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Moynihan's analysis of the indications for operation in cases of obstructive jaundice states the case clearly: "No one living is infallible in the differential diagnosis of obstructive jaundice. The diagnosis is always so difficult and the chance of a life saved so important, that however positive the evidence of malignancy may be I now advise operations in all cases. It is impossible for the most astute clinician or the most subtle pathologist to discover from the anamnesis or from the chemical examination of urine and feces whether a simple or a cancerous disease of the biliary passages and pancreas is present. He may shrewdly guess but a guess is a poor peg on which to hang a man's life. The mortality of cholecystenterostomy now is trifling if we take into account the severity of the disease and the outlook if nothing surgical is attempted. Apart altogether from the prolongation or saving of life, almost every patient will declare that the relief from the maddening torture of itching is worth every sacrifice. I suspect that the mortality from suicide in this disease is greater than that from the operations which afford relief."

To this may be added that the sagacious surgeon will frequently forego the temptation to make a definite diagnosis of the underlying lesion in the head of the pancreas even when through the opened abdominal wall he can see and feel the involved tissues. He will, however, be able to make an anatomic diagnosis and plan the procedure necessary for mechanical relief.

It is inadvisable to cut out a piece of pancreatic tissue for microscopic examination, since this will prolong the operation, invite oozing in the patient predisposed to bleeding by reason of jaundice, and introduce the avoidable risk of a pancreatic fistula.

The diagnostic criteria necessary to the classification of cases of jaundice as surgical or non-surgical are relatively simple, consisting essentially of pain, the behavior of the serum pigment curve and a determination of whether or not bile is reaching the intestine. It may be taken as a rule that jaundice associated with severe pain should be considered surgical unless malignant metastasis can be demonstrated, or a primary malignant growth of the gastro-intestinal tract from which obstructing metastatic growths may have

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arisen. If the onset and the course of the jaundice have been painless, if repeated duodenal siphonage fails to recover bile and if the serum bilirubin curve remains stationary or rises, it may be assumed that an obstructing malignant tumor of the head of the pancreas is present. If the jaundice has commenced without colic, if there is a free flow of bile into the intestine and if the serum pigment curve falls steadily, intrahepatic and therefore non-surgical disharmony is probable. This group of cases should be kept in mind since, while the patients may conceivably recover after an operation such as internal drainage, the recovery is in spite of the surgical procedure, not because of it, and might well be prejudiced by the influence of the anæsthetic or the risk of hæmorrhage. That diagnostic rules in jaundice are fallible is well illustrated by the cases reported here. It will be observed that in only one case, Case VII, was a diagnosis of malignancy proved. It is assumed or at least hoped that the remaining cases are benign tumors, either inflammatory or neoplastic. Statistics show that benign lesions of the pancreas which produce obstruction of the bile passages are rare. These cases are, therefore, exceptional not only in the matter of diagnostic difficulty, but because of the gratifying results attained by the surgical procedure instituted.

The benefits to the patient of the relief of jaundice caused from an obstructing lesion in the head of the pancreas by anastomosis between the distended biliary tract (usually the gall-bladder and occasionally the common bile-duct) and the stomach or intestine, reëstablishing gastro-intestinal biliary continuity, is illustrated by the condition of patients whose cases are reported herewith, particularly by the condition of the patient in Case I in which more than two years have elapsed since operation.

Before the inauguration of present methods of pre-operative preparation, before the use of intravenous injections of calcium chloride [4, 5] and blood transfusion to prevent bleeding, before the development of a method of measuring the amount of bile pigment in the blood and its fluctuation (van den Bergh), and before the development of tests of renal function, the risk of cholecystenterostomy on deeply jaundiced patients was an exceedingly grave one. Kehr [1] stated that in some clinics it varied between 65 and 75 per cent.

Following the application of the principles of preparation previously listed [4, 5] which have been rather generally adopted, the risk of operation on all types of patients with obstructive jaundice has been brought within reasonable limits, and in this clinic is well under 10 per cent.

In a recent paper Wangensteen reported a case of cholangitis following cholecystenterostomy and contrasted the results of anastomosis between the gall-bladder and intestine in experimental animals by Gatewood and Poppins, and others, in which, subsequently, cholangitis invariably occurs with the clinical results of Kehr, Mayo-Robson and Babcock in which cholangitis scarcely ever occurs. After a study of the literature Wangensteen stated that the complication of cholangitis in patients following cholecystenterostomy

has only infrequently been observed and that narrowing or partial occlusion of the stoma, as occurred in the case he reported is the important factor in determining whether the complication of cholangitis will follow.

In the series of eight cases reported here, one of us (Walters) performed cholecystgastrostomy (Fig. 1) on seven deeply jaundiced patients, and cholecystduodenostomy (Fig. 2) on one patient for relief of jaundice due to obstructive lesions in head of the pancreas. An anastomosis of at least 2.5 cm. in diameter, and sometimes 3.5 cm., was made in every instance of cholecystgastrostomy. In the case in which choledochoduodenostomy was performed the immense dilatation of the common duct made possible an anastomotic opening of almost 2 cm. in diameter (Fig. 2).

Six patients are living, free of jaundice and of itching. Three of these feel well, two of whom have gained twenty pounds each. Another reports his condition improved. One reports that he is continually ailing and unable to work. One of the patients on whom cholecystgastrostomy was performed for carcinoma in the head of the pancreas died on the seventh day from what clinically appeared to be renal and hepatic insufficiency. At necropsy the only cause for death found was slight localized peritonitis. Another patient operated on lived comfortably for twenty months after operation. Necropsy by his home physician revealed biliary cirrhosis and terminal pneumonia. Although the tumor in the head of the pancreas had disappeared, the pancreas showed evidence of chronic inflammation.

REPORT OF CASES

CASE I.—A man, aged fifty-two, presented himself January 28, 1924, complaining of having lost appetite and energy and forty pounds in weight during the preceding six months. During the preceding two years he had had recurring jaundice of varying intensity without pain.

Examination.—General examination did not reveal gross abnormalities, except jaundice of moderate degree. The urinalysis, blood count and Wassermann reaction were negative. The test-meal and röntgenograms of the stomach showed nothing abnormal. The patient was advised to return home and await developments. He returned nine months later, stating that following his examination in January, the jaundice had disappeared and he had gained in weight and felt well until October when the jaundice reappeared without pain. A mass was felt in the area of the gall-bladder and was believed to be the distended gall-bladder. The blood count showed the number of leucocytes to be 10,800. The urine contained urobilin and urobilinogen. The blood urea was 30 mg. for each 100 c.c. and the coagulation time was five minutes. A diagnosis was made of biliary obstruction, probably at the head of the pancreas, and the patient was advised to go into the hospital for exploration. The patient preferred to delay exploration and said he would return, which he did November 23, 1925. The attack of jaundice in October, 1924, had lasted for six weeks, then subsided and he gained weight up to 210 pounds. During the summer of 1925 he appeared to be well but in September, painless jaundice again occurred with light stools and dark urine. Appetite failed; he lost thirty pounds and itching was very distressing. Blood count showed 13,800 leucocytes, 3,820,000 erythrocytes and hæmoglobin 61 per cent. The coagulation time was eleven minutes. A diagnosis was made of recurring obstructive jaundice, graded 2, with obstruction at the head of the pancreas. A globular mass in the region of the gall-bladder was palpable.

Operation.—After six days of preparation during which three intravenous injections

of calcium chloride were given, the patient was operated on December 1, 1925. A tumor was found at the head of the pancreas. The gall-bladder was distended, its walls thickened, and rather creamy in color. The liver was normal in size, but there was diffuse cirrhosis. There were several enlarged glands along the common bile-duct which was dilated and distended. At the head of the pancreas was a thickened indurated area which had the "feel of malignancy" but which may have been pancreatitis. Cholecystgastrostomy was performed using three rows of chromic catgut anteriorly and posteriorly (Fig. 1). The anastomosis was made about 5 cm. above the pylorus.

Convalescence was without incident. The patient was allowed to leave the hospital, December 13, and was dismissed from the clinic, December 18, at which time the wound was healed, the jaundice had subsided and the patient's general condition was excellent.

FIG. 1.—Cholecystgastrostomy.

March 21, 1927, sixteen months later, the patient returned to the clinic stating that his condition had been excellent for thirteen months. During the last three months, however, he had lost thirteen pounds in spite of the fact that his appetite was good. During this time he had been troubled with gas and diarrhœa and passed frothy stools. General examination did not reveal anything abnormal. There was no jaundice. The hæmoglobin had returned to 70 per cent.; erythrocytes numbered 4,080,000 and the leucocytes 6,500. Urinalysis was negative. The patient was allowed to return home. November 12, 1927, a letter was received from him stating that he was getting along fairly well, feeling about 50 per cent. better than when examined in the clinic in March. He noted improvement each week and was gaining a little weight; his weight at this time was 185 pounds. Appetite was fairly good and the stools were normal. Jaundice had not been present since the operation. The urine was normal. A letter dated February 27, 1928, stated that stools were more natural and that he was having epigastric pains which were relieved by the passage of gas.

Comment.—The fact that the jaundice had cleared completely on several occasions over a period of two years prior to operation made us feel that malignancy of the bile passages or pancreas was improbable, especially as the patient had gained weight and had shown general improvement in health during the free intervals. A "silent" or painless common duct stone was a possibility and statistically probable. The last attack was associated with slight rises in temperature. Injury to the liver was anticipated and drainage of the biliary tract seemed clearly indicated, preferably permanent internal drainage.

Although at the time of the operation a differential diagnosis of chronic pancreatitis and carcinoma could not be made, in the light of subsequent events the lesion is judged to be chronic pancreatitis.

CASE II.—A man, aged fifty-seven, presented himself August 3, 1927, with a history of stomach trouble for two months and loss of twenty pounds. Distress came on two or

three hours after meals and at 3:00 A.M. and was relieved by eating. Prior to this for a period of thirty years he had had occasional attacks of distress in the epigastric region lasting from one to two hours, and occurring on three or four successive days with intervals of freedom from attacks of several months. This type of distress had been without relation to meals. Two weeks previous to examination jaundice was noticed. The onset was not associated with pain, other than that already described.

Examination.—Jaundice, graded 2, was noted in the skin and sclerotics. There was a mass at the level of the umbilicus. Serum bilirubin was 15 mg. for each 100 c.c. of blood. The blood count showed hæmoglobin 61 per cent. and leucocytes 8,800. Bile in the urine was graded 2. Röntgenogram of the stomach showed a deformity of the duodenum suggestive of ulcer. A fractional test-meal showed total acidity 50, free hydrochloric acid 28 and 90 c.c. of fluid in the stomach at the end of one hour. Carcinoma of the pancreas or duodenal ulcer perforating onto the pancreas with obstruction of the common bile-duct was considered pre-operatively. Exploration was advised. The patient was under observation in the hospital for ten days during which time he was prepared for operation in the usual manner. Bile was not obtained by duodenal drainage on four occasions from August 9 to 15. Serum bilirubin on three occasions was as follows: August 20, 20.9; August 22, 16.4; August 31, 18.3. The coagulation time was seven minutes and thirty seconds.

Operation.—At operation August 23, 1927, a mass approximately 7 cm. in diameter was found in the head of the pancreas with a crater approximately 1.5 cm. in diameter. To this the duodenum was closely adherent and it is possible that the mass was either a large ulcer on the posterior wall of the duodenum perforating into the pancreas or ulcerating carcinoma of the head of the pancreas. In either event it appeared to be the cause of the biliary obstruction. The gall-bladder was distended and contained about 500 c.c. of thick tarry bile. There were no gall-stones. The gall-bladder was emptied with a trocar and in view of the condition present it seemed advisable to perform a cholecystgastrostomy, which was done using three rows of sutures posteriorly and anteriorly and surrounding the anastomosis with omentum. Two Penrose cigarette drains were used.

The post-operative course was without incident. There was slight gastric retention for the first five days but no fever. The patient was dismissed from the hospital September 10, and from the clinic, September 23, at which time the wound was healed and the general condition good. The day before dismissal the serum bilirubin was 8.3.

A letter from the patient October 10, stated that he stood the trip home well, and that he was feeling quite strong but not gaining weight. His appetite was good and he was eating everything. He had gas pains every day and his bowels were loose, moving several times a day. A letter January 7, 1928, stated that he was getting stronger every day and believed that by spring he would be able to look after the work on the farm. A letter March 1, stated that he had severe epigastric pains. His appetite was good but he had not gained weight. There was not any jaundice or itching.

Case III.—A woman, aged fifty-one, registered August 4, 1927. She gave a two-year history of attacks of epigastric pain coming at intervals of from two weeks to two months. The pain radiated from the epigastrium to the interscapular region, was not induced or relieved by food and was not eased by soda. The recent colics were severe, being relieved only by the hypodermic injection of opiates. Three months before registration jaundice appeared following colic and had persisted although showing variation in intensity. There had been occasional vomiting, usually after the patient had taken sodium bicarbonate. The loss in weight was twenty-five pounds in four months. The stools and urine had varied in color. There had not been any chills or fever.

Examination.—Slight epigastric tenderness was present, the liver was palpable, and the spleen was not felt. Hæmoglobin was 47 per cent.; erythrocytes numbered 3,540,000, leucocytes 7,400. Fluoroscopic examination of the stomach showed nothing abnormal. Siphonage of the duodenal contents on August 9, 1927, did not recover bile. Daily

serum bilirubin estimations from August 8 to 12 showed 6.4, 5.75, 6.2 and 4.1 mg. for each 100 c.c. Our clinical impression was that this patient had gall-stones and that one or more stones had escaped into the common bile-duct.

The patient was sent to the hospital for pre-operative preparation. Intravenous injections of calcium chloride were given.

Operation.—At operation, August 13, 1927, a hard, indurated mass was found in the head of the pancreas and throughout the pancreas just below the lesser curvature of the stomach multiple nodules could be felt. There was a suggestion of free fluid in the abdomen. Further evidence of carcinoma was not found. The gall-bladder was moderately distended but was not typical of complete pancreatic obstruction. Stones were not palpated in the gall-bladder or the common bile-duct. Cholecystgastrostomy was performed using three rows of chromic catgut sutures anteriorly and posteriorly and protecting the suture line with omentum. Three Penrose cigarette drains were inserted.

The post-operative convalescence was without incident. Two degrees of fever occurred on the first and second days following operation and from then until dismissal, August 27, the patient ran a normal course with a normal pulse rate throughout. She was dismissed from the clinic, September 2, at which time the wound was healed and her general condition was good. Three days before dismissal the hæmoglobin was 60 per cent. with practically no changes in the number of blood cells. The serum bilirubin, September 2, was 1.8 mg. for each 100 c.c., direct reaction.

A letter from the patient's husband dated November 25, 1927, stated that she had been well and had gained from fifteen to twenty pounds. She had noticed some discomfort in the wound when doing unaccustomed work. Appetite was good and she was free of jaundice. Letters December 10, 1927, and January 13, 1928, stated that the patient continued to do well. She still had some tenderness at the site of the operation and some pain in the right hip, but was free of jaundice and itching.

Case IV.—A man, aged sixty, was examined December 13, 1927. In 1923, he had had attacks of colic for four or five days which required morphine for relief. In 1924, he had had attacks of pain and was taken to a hospital and operated on, at which time he was told that the gall-bladder had ruptured and several large stones were removed from the abdomen. The gall-bladder was not disturbed and the patient made a good recovery. In the winter of 1926, he had another slight attack of pain lasting about a week. The urine was dark and stools clay-colored but there was no jaundice. In October, 1927, jaundice appeared for the first time. The onset and subsequent course were without pain or marked dyspepsia. He had lost twenty pounds. Pruritus had been severe early in the course of the jaundice but had disappeared.

Examination.—Icterus of skin and sclerotics was marked; hæmoglobin was 45 per cent.; the erythrocytes numbered 3,000,000 and leucocytes 6,300. The coagulation time was nine minutes and the urine contained bile, a few hyaline casts and an occasional red blood cell. A fairly free flow of bile was obtained by duodenal drainage. The serum bilirubin on admission was 11.5 mg. but decreased to 5.8 mg. Enlargement of the liver was not demonstrated and the gall-bladder was not palpable. During a period of seventeen days fever was intermittent and high. A clinical diagnosis was made of incomplete benign stricture of the common duct based on the fact that although stones were reported to have been found at the operation elsewhere, pain was not associated with the onset or course of the jaundice. Malignancy was not considered probable because there was a fairly free flow of bile into the intestine and the serum bilirubin decreased about 50 per cent. It was decided to operate when the serum level of the pigment had become stationary and after the usual intravenous administration of calcium chloride.

Operation.—January 19, 1928, a right rectus incision was made, thus securing an excellent exposure of the gall-bladder and the cystic and common bile-ducts. The common duct was approximately 2.5 cm. in diameter. The cystic duct was distended and dilated and the gall-bladder was distended. The walls of the gall-bladder appeared normal. Exploration of the pancreas showed an irregular, indurated tumor in the head forming a

mass approximately 4 cm. in diameter. An anastomosis was made between the common bile-duct and duodenum inasmuch as the common bile-duct lay directly on the second portion of the duodenum whereas the gall-bladder, because of the scarring from the former operation, lay at a much lower level (Fig. 2). Three rows of chromic catgut were used. An accurate anastomosis was made, at the conclusion of which the pylorus was held to the right of the median line by two interrupted sutures between the anterior wall of the stomach and the falciform ligament of the liver. Two Penrose drains were inserted.

Convalescence was uneventful with the exception that the day after the operation the temperature was 100.5°. The patient was dismissed from the hospital, February 1, and from the clinic February 6, at which time the wound was healed and the general condition excellent. The serum bilirubin was 1.7 mg. and stools were normal in color.

FIG. 2.—Choledochoduodenostomy.

March 27, 1928, two months following operation, a letter stated that the patient had gained thirty pounds, that he had not been jaundiced, was feeling fine and eating everything.

CASE V.—A man, aged thirty-two, came to the clinic March 22, 1927, with a complaint of burning in the stomach and red urine. The gastric trouble had affected him for six months and was more noticeable when the stomach was empty. Nausea and vomiting occurred occasionally, usually about half an hour after meals. He also experienced a sharp pain in the left epigastrium occasionally, at times a slight dull pain under the right costal margin, infrequent dull pain between the shoulder blades and sometimes pain across the back in the upper lumbar area. Six years prior to examination a severe epigastric pain had lasted three days and required morphine for relief. Three weeks prior to admission jaundice was noted. The onset was not associated with pain. The patient was an Italian who had been in America for five years. He had had malaria at the age of twelve and influenza at the age of twenty-one.

Examination.—There was tenderness in the right upper quadrant, the liver edge could not be felt, the spleen was not palpable, and icterus of the skin and sclerotics was marked. The stools did not contain parasites, ova or excess of fat; the urine showed a trace of bile and a few hyaline and granular casts. A fairly free flow of bile was obtained in duodenal drainage. The serum bilirubin, March 24, was 10 mg. and March 27, 5.3 mg. There was no anemia. Röntgen-ray examination of the stomach and duodenum did not show anything abnormal. Clinically there appeared to be an incomplete obstruction of the common duct, probably due to stones. This opinion was based on the degree of

pain, the behavior of the serum bilirubin curve, the associated dyspepsia and the fact that some bile was reaching the intestine.

Patient was under pre-operative preparation for six days during which time he received intravenous injections of calcium chloride.

Operation.—At operation, April 2, 1927, the head of the pancreas was found to be enlarged to about three times normal size. The remaining portion of the pancreas was lobulated and showed definite evidence of pancreatitis. The liver was enlarged and congested. The gall-bladder was enlarged and congested but did not contain stones. Cholecystgastrostomy was performed using two rows of chromic catgut anteriorly and posteriorly and surrounding the anastomosis with omentum. Two Penrose drains were inserted.

Convalescence was excellent with two degrees of fever on the second day. The patient was dismissed from the hospital April 18, and from the clinic April 28, at which time the wound was completely healed and the general condition excellent. The jaundice was disappearing but there was still slight itching.

The patient returned to the clinic June 13, complaining of burning in the epigastrium just below the umbilicus, before breakfast. He also complained of itching or burning in the rectum.

Examination.—There was no evidence of jaundice. The serum bilirubin June 14 was 1 mg. for each 100 c.c., indirect reaction. The blood was normal. Fractional test-meal showed total acidity 48, free hydrochloric acid 28, 150 c.c. of fluid at the end of an hour and a slight tinge of bile. The differential blood count on 200 cells showed 29.5 per cent. lymphocytes, 0.5 per cent. large mononuclears, 3.5 per cent. transitionals, 65.0 per cent. neutrophils and 1.5 per cent. eosinophils. The Wassermann reaction was negative.

A letter from the patient dated December 2, 1927, stated that his general condition was improving. He continued to have burning in the epigastrium before breakfast.

Case VI.—A woman, aged fifty-one, registered August 29, 1927. For twenty-five years she had had recurring severe upper abdominal colic, the pain starting in the epigastrium and radiating around both costal margins. The attacks lasted for from one to several days and were succeeded by residual soreness over the upper half of the abdomen. Between attacks she felt fairly well but had a feeling of epigastric fullness after eating and occasionally regurgitated sour material and belched gas. Two months before registration a severe spell of upper abdominal colic had lasted two weeks; following this jaundice appeared with pruritus and acholic stools. Duodenal siphonage by her home physician had not resulted in recovery of bile. She had lost twenty pounds in weight in six weeks.

Examination.—The skin was bronze-colored, the sclerotics yellow, the epigastrium tender, the right lobe of the liver much enlarged, smooth and tender, and the gall-bladder palpable; the spleen was not felt; there was no ascites. The hæmoglobin was 68 per cent., erythrocytes numbered 4,280,000 and leucocytes 3,500. The urine contained bile but was normal otherwise. The blood urea August 30 was 30 mg. for each 100 c.c. The patient was hospitalized for observation. The serum bilirubin on three occasions was 11.5, 12.4 and 11.2 mg. for each 100 c.c. of blood. Duodenal siphonage did not recover bile. The coagulation time was seven minutes. There was no fever. The long history of colics followed eventually by persistent jaundice led to a diagnosis of cholecystitis with stones in the gall-bladder and the common duct. The question of associated malignancy was discussed because of the lack of appreciable fluctuation of pigment in the serum readings, the enlarged liver and the failure to obtain bile by duodenal drainage. An intravenous injection of 0.5 gm. of calcium chloride on each of three successive days was given.

Operation.—At operation September 10, 1927, a large tumor was found at the head of the pancreas which was so hard that the possibility of a stone in the common duct was considered, but the irregularity and the large size of the mass led to the diagnosis of carcinoma of the head of the pancreas. The gall-bladder was distended with very dark green bile. The common duct was dilated to approximately 4 cm. in diameter. Cholecyst-

gastrostomy was made using three rows of sutures anteriorly and posteriorly, the line of suture being protected with gastrohepatic omentum. Two Penrose drains were inserted.

Immediately following operation the patient ran a septic type of temperature with gastric retention from the first with a rapid drop in hæmoglobin. September 15, the hæmoglobin was 15 per cent. and the erythrocytes 8,400. A transfusion of 500 c.c. of blood was given immediately. The following day the blood count showed hæmoglobin 30 per cent. and erythrocytes 1,640,000. The blood urea September 14 was 214 mg. for each 100 c.c. of the blood, carbon dioxide combining power was 50 per cent. by volume and chlorides were 480 mg. for each 100 c.c. September 15, the blood urea was 247 and the carbon dioxide combining power 60 per cent. September 16, the blood urea was 241. The serum bilirubin was 19.9 mg. on September 9, 14.6 mg. on September 14, and 16.2 mg. on September 15. The patient died September 17, seven days after the operation. Necropsy showed carcinoma of the pancreas with occlusion of the pancreatic portion of the common bile-duct. There was a slight amount of local peritonitis and a small hæmatoma in the pre-peritoneal portion of the abdominal wall. From the time of the operation the urinary output was considerably decreased in proportion to the fluid intake.

Case VII.—A Polish Jew, aged fifty-five, presented himself April 24, 1927, with a complaint of intense itching. Six years previously glycosuria had been discovered during an examination for life insurance. At that time he weighed 220 pounds. On dietary restriction his weight had been reduced to 165 pounds where it had remained for five years. During the last year he had lost an additional forty pounds. He was not aware of jaundice which was first detected at the clinic. The pruritus was of nine months' duration and had become very troublesome in the last three months. He had not had colic, but six or seven months before admission and on several other occasions he had had pain under the right costal margin and had treated it by the application of a hot water bag.

Examination.—The skin was dark and sclerotics slightly icteric. The liver was not enlarged; the hæmoglobin was 67 per cent., the erythrocytes numbered 3,770,000; the urine did not contain sugar but contained a trace of bile; the serum bilirubin on three readings over a period of ten days was 5.37, 5.0 and 6.7 mg. for each 100 c.c., the blood sugar was 0.13 mg. per cent. and a single duodenal drainage failed to secure bile. The diagnosis was indeterminate. The history of pain, the negative duodenal drainage, the associated diabetes and the intense pruritus seemed to warrant a search for obstruction in the bile-duct.

Operation.—At operation May 7, 1927, considerable enlargement of the head of the pancreas with moderate induration was found. The gall-bladder was distended to the shape of a gourd and its wall was thin. It was emptied with the trocar of its bile which was dark green and contained granules of bile pigment. The interior of the gall-bladder was explored with the finger; gall-stones were not found. Cholecystgastrostomy was performed anastomosing the gall-bladder to the stomach about 5 cm. above the pylorus. In the anastomosis three rows of sutures were used posteriorly and two rows anteriorly; the angle was protected by bringing gastrohepatic omentum about it.

The patient ran a variable fever from one to three degrees for the first four days after operation. The leucocyte count was 15,900 May 9, 12,000 May 10, and 9,500 May 12. He was dismissed from the hospital May 21, at which time the jaundice had slightly subsided but had not entirely disappeared. He was given treatment for subacute prostatitis and vesiculitis and dismissed from the clinic, June 17. A letter dated March 1, 1928, stated that the patient has not had any jaundice but itching has continued. He has also noticed light stools.

Case VIII.—A man, aged fifty-nine, registered December 30, 1925. He had been quite well until the previous two months when he began to experience discomfort and distress after eating, with occasional pain in the right upper quadrant of the abdomen. The urine became colored and jaundice appeared a few days later and increased progressively. The stools were white. He had very little pain but severe itching of the skin and considerable nausea.

Examination.—Jaundice was graded 3. Tenderness in the epigastrium was present. The liver was enlarged and there was a resistant mass in the same region which could not be definitely identified as the gall-bladder. Urinalysis was negative. The blood count showed hæmoglobin 65 per cent., erythrocytes 3,760,000 and leucocytes 6,300. The serum bilirubin was 23.8 by the direct van den Bergh test. Coagulation time was seven minutes and forty-five seconds. A diagnosis was made of obstructive jaundice from a tumor in the head of the pancreas. The patient was sent into the hospital for observation and preparation for operation. During the ten days of preparation the serum bilirubin varied between 23.8 mg. and 25 mg. for each 100 c.c. The coagulation time was eight minutes and forty-five seconds on January 6. Calcium chloride was given intravenously during this time.

Operation.—At operation January 9, 1926, a tumor was found in the head of the pancreas. The gall-bladder was somewhat distended and its walls were slightly thickened and contained fat. The common duct was slightly enlarged but the walls were blue and did not show evidence of inflammatory change. Stones were not felt in the common duct or gall-bladder. Cholecystgastrostomy was performed and the anastomosis was protected by omentum. The bile was golden yellow.

Convalescence subsequent to operation was satisfactory. The blood urea January 25 was 31 mg.; carbon dioxide combining power was 56 per cent., chlorides 465 mg., and serum bilirubin 14.8 mg. The patient was dismissed from the hospital on the eighteenth day and allowed to return directly home.

The patient returned for reëxamination May 6, 1927, stating that following his dismissal he had had pruritus, chills and sweats and had lost twenty-five pounds. At the end of seven months he had lost forty-two pounds. He continued to lose weight until the spring of 1927, when he began to gain, his weight increasing from 133 to 148 pounds by April, 1927. Ten teeth with abscessed roots were extracted, bleeding continuing for thirty hours. At the time of his examination he had been free of chills and fever for one month. He had noticed abdominal swelling, clay-colored stools and itching with general abdominal distress three or four hours after meals; soda afforded some relief.

Jaundice, anemia, and cachexia were now graded 2. The systolic blood pressure was 100, the diastolic 68. The hæmoglobin was 40 per cent., erythrocytes 2,200,000 and leucocytes 6,100. Bile in the urine was graded 2. The serum bilirubin was 10.2; the coagulation time was ten minutes and the blood urea 12. The patient was allowed to return home May 10. A letter from his physician stated that the patient died August 1, of terminal bronchopneumonia complicating the biliary disease. He had marked jaundice before death and considerable pruritus. Necropsy revealed a moderately enlarged and very firm liver which was proved microscopically to be a hypertrophic biliary type of cirrhosis. Pancreas was slightly enlarged and rather firm from pancreatitis. Malignancy was not found in any of the organs which were examined.

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SUBCUTANEOUS RUPTURE OF THE STOMACH; TRAUMATIC AND SPONTANEOUS

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Subcutaneous rupture of the stomach is the occurrence of gastric rupture without perforation of the abdominal wall. Perforated ulcers and such injuries as stab wounds, gunshot or other direct penetrations of the stomach wall are excluded.

Traumatic rupture of the stomach of this type is comparatively uncommon. Makin (1870) reported 282 cases of abdominal injuries, eighty-nine of which had rupture of internal viscera with not one gastric rupture. Neuman * likewise mentions no gastric rupture in fifty-four reported cases of ruptured abdominal viscera. Petry (1896) in a much larger series reported 219 cases of rupture of the gastrointestinal tract. Twenty-one were in the stomach (thirteen traumatic and eight spontaneous), 163 were in the small intestines and twenty-six in the large intestines. Particular interest can be attached to the cases associated with severe trauma and little or no external evidence, but when rupture of the stomach occurs with very slight or even no external trauma it becomes of far greater importance from a surgical as well as medico-legal aspect.

We have made a survey of the literature and have divided the cases of subcutaneous rupture of the stomach into three main groups: those following severe and moderate traumata, those following slight trauma and the spontaneous ruptures.

Severe and Moderate Trauma.—We collected from the literature thirty-one cases of subcutaneous gastric rupture after severe and moderate traumata. Twenty-one or 65.6 per cent. showed other injuries, mostly internal. The spleen is the organ most often injured in association with rupture of the stomach: seven cases or 22 per cent., and almost as frequent is the liver—six or 18.7 per cent.

To the thirty-one cases collected we add the following which will be described briefly:

Case No. 1.—A laborer, age thirty-three years, was admitted to Mount Sinai Hospital, October 17, 1924, with a history of having been struck across the abdomen with a plank. He was in profound shock, pallid, restless, with rigid abdomen and shifting dulness in the flanks. There was an abrasion of the skin of the abdomen on either side of the umbilicus. At operation, soon after the accident, a rent running transversely four inches in length was found in the fundus of the stomach, on the anterior surface. The abdominal cavity was filled with blood and gastric contents. The patient died fifteen hours after operation.

At autopsy, in addition, a laceration of the renal surface of the spleen 2 centimetres in diameter was found.

* From Eisendrath.

Mechanism and Type of Injury.—Rupture of the stomach occurs in these cases in one of three ways—by bursting, by crushing or by tearing. Force may act directly or indirectly and may be diffuse (run over, crushing, fall from height) or circumscribed (kicks, blows or fall on object). It is difficult to predict from the type of injury the exact mechanism of rupture. In a diffuse injury with crushing of the external body, we expect a crushing injury to the stomach, but instead, especially if the stomach be filled, a bursting type of rupture may occur. In the localized type of injury instead of being crushed against the spinal column, the stomach may burst like a paper bag which is struck when blown up. Only if there is evidence of rupture of the anterior and posterior wall opposite each other in direct line with the spinal column, can a crushing mechanism be diagnosed with certainty. There are five cases of this kind in the first group (diffuse injury Table I), and three in the second group (localized injury Table II). Several of the others are possibly of this type also. Tearing of the stomach may occur, for example, when the abdomen is struck by an object which catches the greater omentum and carries it distally; or in a fall from a great height, the stomach, at the moment of impact, is carried on by its own momentum and tears at its attachments. Because of the difficulty of separating the cases of this group according to the mechanism of injury, we have arbitrarily divided them into those due to localized, and those due to diffused traumata.

The diffuse type of injury is the more common; twenty-one or 65.6 per cent., and it is in this type of injury that other organs are prone to be injured at the same time. This is probably due to the force or impact acting at several points, thereby allowing a greater opportunity for other structures to be involved. Of twenty-one cases with diffuse type of trauma, sixteen or 76.2 per cent. had other injuries, whereas of eleven cases with circumscribed type of trauma only six or 54.5 per cent. had other injuries and three of these consisted only of ruptured recti muscles. The internal organs were injured in thirteen or 62 per cent. of the former type as against two or 18 per cent. of the latter type of injury. Rupture of the liver or spleen occurred in eleven or 52 per cent. of the first group and only in two cases of the second group.

Incomplete rupture of the stomach may occur as shown in the cases of Poland, Ziegler and Clayton. Duplay cites, as examples, of mucosal tears, three cases which after insults to the abdominal region vomited blood, but spontaneous healing occurred in all. Hoffmann cites four cases of mucosal tears and Leube reports one. This, however, brings up the question of traumatic ulcers, a subject that will not be discussed in this report.

External evidence of injury is more often encountered in the circumscribed type, five of eleven cases; in the diffuse type only three. The lack of this evidence seems almost incredible with the types of injury which were sustained in some of the cases. The following report exemplifies: *

A male, nineteen, was run over by three carriages, brake, van and engine. The latter weighed thirty tons. There was not the smallest wound on the body and only

* British Med. Jour., August 20, 1870, vol. ii, p. 185.

a few abrasions of the cuticle across the abdomen. At autopsy the abdominal muscles, back muscles, right kidney, transverse colon, ileum and body of the third lumbar vertebræ were found cut across, but the skin showed only abrasions and ecchymoses.

The outstanding symptoms are those of shock which is usually marked. Abdominal pain, rigidity and tenderness are generally present. Of twenty cases giving symptoms, thirteen had vomiting. Nine cases vomited blood and in two other cases blood trickled from the nares. This may or may not have come from the stomach. Vomiting of blood has always been stressed as a prominent symptom. In the above cases it occurred at least in 50 per cent.

The exact site of rupture is often not stated in the records. In twenty-one reports the location was described. Fourteen of these, or two-thirds, were in the region of the pylorus. This is undoubtedly because of the greater degree of exposure to trauma that this site offers and its situation over the spinal column. The anterior wall was affected in seventeen of the twenty-four cases in the reports in which the surface was mentioned. The greater and lesser curvatures were equally involved five times. The lesser curvature and cardia which are well protected are probably involved only in the bursting type of rupture. In this type of rupture other rents may be present. These are often incomplete tears and might be overlooked (case of Clayton).

The prognosis depends on many factors among which may be mentioned (1) the severity of trauma, (2) injury to other organs, (3) shock, (4) blood loss, and probably of most importance is (5) the time of operation after the injury. Before laparotomy came into general use (1890), death was practically always the outcome in complete ruptures. Now, with early operation, the prognosis becomes much better. A small percentage recover spontaneously. Especially is this true of incomplete or mucosal rupture. (Duplay, Hoffmann, Leube.) The case of Rose showed evidence of spontaneous subsidence by adhesion to the liver in which an abscess developed. Poland and H. Brush cite cases of gastric fistula following trauma and Ettmuller * cites two cases of abdominal trauma with rupture of stomach and resultant spontaneous cure by the development of gastric fistulæ. Of eleven cases operated seven recovered and four died; three of the eleven were operated two to four weeks after the accident. Spontaneous healing had occurred to some degree and the laparotomy was done to correct the complication which had arisen, such as hæmatoma of stomach wall and abscess formation, and not primarily to suture the rent. Of eight operated soon after the accident four died; of these one case had an incomplete tear (tear of mucous membrane) which was not found at operation and a rent in the spleen was overlooked in another case. In the remaining two the length of time from the accident until operation is not stated. However, early operation should cut down the mortality of these cases.

Rupture Due to Slight Injury.—The occurrence of rupture of the stomach after severe abdominal injuries is, as noted, infrequent. This, however, seems

* O. Marchetti.

well accounted for by the protected position of the greater part of the stomach. More surprising by far are those cases in which rupture of the gastric wall occurs after a slight trauma apparently out of all proportion to the lesion.

CASE No. 2.—A boy, aged six, following dinner which consisted largely of beans ran after his father, tripped and fell. He experienced marked abdominal pain, was admitted to Mount Sinai Hospital one and a half hours after the accident, March 19, 1927, and presented a picture of shock. He was pallid, the respirations were rapid, his pulse was 160 and thready. There was a lacerated wound of the forehead. The abdomen was distended, tender; liver dulness was obliterated and shifting dulness was present in the flanks. He was tender per rectum and fulness was felt in the cul-de-sac. There was no external signs of injury to the abdomen. Laparotomy was immediately performed. The abdominal cavity contained undigested food (beans) and stomach contents but very little blood. A three and one-half centimetre rent in the anterior wall of the stomach near the greater curvature running parallel to it was found and sutured. The shock increased and in spite of a transfusion and stimulation, the child ceased seven and a half hours after the operation. Autopsy about six hours later by Dr. Klemperer revealed the following as taken from the protocol:

"A well-nourished, well-developed, white child of about six years of age. Rigor mortis is present and there is post-mortem lividity on the back and dependent portions. There is a deep laceration, 2.6 centimetres long with sharp, gaping edges on the left forehead, which extends down to the bone and through the periosteum. The underlying bone, however, appears normal. There is an excoriation of the skin on the right elbow. There is a very insignificant subcutaneous extravasation of blood in the left side of the thorax in the mid-axillary line at the eighth rib, about the size of a pea, irregular and bluish-red in color.

The abdominal cavity contains about 200 cubic centimetres of fluid and a very large amount of partially digested lima beans. The parietal and visceral peritoneum is reddened, the blood vessels are injected, but the peritoneum is glistening. The parietal pleura, at the costo-chondral junction of the eighth rib on the left, shows an irregular, subpleural hæmorrhage of the size of a dime. A small subpleural hæmorrhage is found in the diaphragm on the left side.

Stomach.—There is a lacerated wound 3 centimetres in length in the anterior wall of the stomach nearer to the greater curvature, closed by sutures. There is another perforation 1 centimetre long and unrepaired in the anterior wall of the fundus at the level of the cardia. Within the sub-mucosa of the fundus there are diffuse extravasations of blood which shine through the mucosa. The stomach contains partially digested beans, but no blood.

To Summarize.—A boy of six, shortly after dinner tripped and fell. He was brought to the hospital in a condition of shock, with a laceration of the forehead and no other signs of external traumata. A laparotomy revealed a laceration of the stomach which was sutured. The patient died and at autopsy a second laceration of the stomach was disclosed and as evidence of external trauma to the abdomen only an insignificant bluish-red area in the left axillary line."

A review of the literature for similar cases reveals eight reports which are tabulated in Table III.*

In all the cases collected, the trauma was slight and such as is encountered daily. Some of these cases were reported by their original authors and by subsequent writers as examples of spontaneous rupture, but we prefer to

* Arrot's case has not been included in our series because of insufficient data. He cites the case of a small boy who fell a short height from a ladder. There was no external mark but a large rent was found in the stomach.

include them under "simple trauma" if there is a history of such, no matter how slight. The mechanism here is undoubtedly somewhat allied to spontaneous ruptures which will be discussed more fully under that heading. Two points to be considered are: 1, whether the stomach is normal or diseased; 2, the effect of distention.

There is very slight indication of the importance of a preëxisting pathological condition in these cases. However, it is self-evident that very slight trauma may cause a perforation of a diseased stomach wall. Reports of such incidents are not so rare. Perforation of gastric ulcer after slight trauma often takes place. Marianschik reports rupture of a gastric ulcer by a jump of three feet from wagon to ground. Ambrose describes a case of ruptured gastric ulcer by bending over, drilling with an auger, and Dubs reports volvulus and rupture of gastric ulcer in a diaphragmatic hernia.

As examples of perforation of carcinoma following slight trauma to the stomach, we briefly give the following: Strassmann reports the case of a man with carcinoma of the stomach who, after lavage, collapsed. At autopsy a rent two inches long was found in the middle of the lesser curvature and parallel to it. The surrounding region was discolored, dark red, and the stomach wall was thin. The carcinoma began three inches below the tear. Strassmann thinks there was first a rupture of a small vessel. It is noteworthy that the perforation need not be at the site of the neoplasm. In a case reported by Morrison, two rents, parallel, one inch each, were found extending through the carcinomatous area which was in the pyloric region.

Distention was present quite consistently (Table III). In the first two cases which were under the influence of opium the stomach had been distended by lavage. In the third case there was distention attributed by Revilliod to nervousness (nervous distention). The fourth case had distention associated with chronic gastritis. The other cases had food in the stomach besides such gases and secretions which may have accrued.

Failure of the contents of the stomach to pass through the pylorus or cardia at the moment of injury certainly accounts for the fatal increase in tension which leads to rupture. This is due to the tonicity of these openings which is controlled by a nervous mechanism and is not easily and suddenly overcome. The normal tonicity may be further increased by cardiospasm or pylorospasm. At the cardia a passive valve closure (Kelling), or at the pylorus an artery-mesentery obstruction (Albrecht), may take place. Angulations, fixations, or pressure of a dilated duodenum (Busch) act in the same way.

In two of the cases (4 and 5) a sudden increased intra-abdominal pressure seems to have had some additional bearing. By bending over, the diaphragm is splinted and the abdominal muscles become tense. The intraperitoneal space decreased and the intra-abdominal pressure proportionately increased. Sauerbruch thinks this is of great importance and accounts for most so-called spontaneous ruptures. H. Brush cites a case of a male, twenty-three, who after a heavy meal attempted to lift a large stone. He felt pain in

the stomach region and suffered until death, some years later, from pain and vomiting. At autopsy, a fistulous opening was found at the pyloric end of the stomach on the posterior surface opening into the pancreatic duct.

The mechanism of rupture has been likened to a distended toy balloon which when slightly filled will withstand considerable trauma, but when distended will rupture very readily and with little trauma. Max Busch draws attention to the factors of tonic and atonic dilatation and concludes that rupture occurs more frequently in the first type.

Finally, we must not lose sight of the fact that what may appear on the surface to be but a trivial injury may really be of considerable degree. When, as in case six, a boy goes coasting with his sled and alights on it "belly first", his abdomen receives the brunt of the fall and practically his entire weight or its equivalent in force may be exerted on the stomach.

Of these cases only one was operated upon. Unfortunately a second rent was overlooked and the patient died. Of those unoperated, none recovered. If it is only kept in mind that rupture of the stomach can occur with apparently little trauma, even though rarely, early diagnosis can be made and operation advised. The history of a patient having eaten a large meal or distention preceding the trauma is common. A valuable aid to diagnosis is the X-ray, which will often reveal air subdiaphragmatically.

Spontaneous Rupture.—The question of spontaneous rupture of the stomach has been discussed for a long time and Percy and Lerent (1819) devote several pages to the discussion and cite numerous cases. However, Andral (1831) though mentioning spontaneous rupture in animals has not seen a true case in human. He already believed that the cases reported had occurred in diseased stomachs. Even as late as the nineteenth century spontaneous ruptures of the healthy stomach in man were thought to be frequent. This is easily understood. Not until 1829–35 did Cruveillier describe ulcer of the stomach and its perforation. Lefévre (1842) takes up the question and collects eight cases including one of his own. These cases, however, are not very convincing and the preëxistence of an ulcer cannot be ruled out. Later on with increasing critical investigation, the number of case reports becomes very small. Orth does not believe that a healthy stomach can rupture. MacCallum, Delafield and Prudden, Aschoff and Kaufmann do not even mention such an occurrence, whereas Hauser devotes a full chapter to the question. We collected critically the observed cases of the literature which are tabulated in Table IV.*

Before discussing them we would like to review in brief the experiments which have been undertaken by various authors to cast light on the subject.

Lefévre (1842–1859) filled stomachs and compressed them to see where the tears occur. He found that they occurred mostly in the fundus and that the serosa tore first. But when filled with air, emphysema of the stomach wall occurred in the lesser curva-

* It is well known that rupture of the stomach often takes place in ruminating animals after feeding on fresh clover from the development of carbonic acid gas from fermentation of contents of the pouch.

ture nearer to the cardia, *i.e.* the mucous membrane tore first. He observed spontaneous ruptures in animals and concludes that it may occur in human beings.

Revilliod (1885) found that the stomach would hold 4,000 cubic centimetres before rupture and that the rents occurred in mid-stomach, both anterior and posterior walls.

Key Aberg (1897) filled the stomachs in situ of corpses in a sitting position, having the abdominal wall both open and closed. He used a funnel and rubber tube via the œsophagus. When the funnel was held three-quarter metres above, only 4,000 cubic centimetres would enter the stomach, but when the funnel was raised one to one and one half metres above, he could put in as high as 5,000 to 6,000 cubic centimetres before the stomach burst. At the end of 4,000 cubic centimetres he regularly found ruptures in the mucous membrane along the lesser curvature and parallel to it. With greater filling stellate tears occurred at cardia and he often found tears of the serosa before complete rupture occurred. The site of the rents he feels is due not to the anatomical structure, but to the form which the stomach assumes. It is an inverted cone with a convexity at the lesser curvature. With distention or filling, the stomach tends to assume the shape of a sphere. Thereby the lesser curvature has the greatest excursion, that is, it must stretch the most and thus tears more frequently at this site.

Frankel (1906) investigated by experiments the elasticity in various parts of the stomach. Using E as the cöefficient of elasticity, he utilized the formula E equals $\frac{Pl}{Q\lambda}$ where l equals the length of the examined strip, P equals the load, λ equals lengthening or degree of stretching, and Q equals the cross section. He used stomachs of dogs, children and adults. He concludes that the elasticity of the stomach wall depends upon the elasticity of the muscular coat. The elasticity coëfficient of the mucosa is less than that of the muscle; with equal loads the stretching at either curvature is greater crosswise than lengthwise and that the neighborhood of the lesser curvature has a lesser coëfficient of elasticity than the rest of the stomach. Besides the resistance of the muscle, he maintains that the form of the stomach and absence of mucosal folds on the lesser curvature play a rôle in the production of ruptures. As a practical point he offers the statement that he could not produce a complete rupture of a child's stomach by distention with fluids from ordinary funnel and tube.

Talma (1890) experimenting with rabbits found with marked distention he obtained ulcers, areas of softening and infarcts in the fundus, also diffuse hæmorrhagic infiltration and in other place localized bleeding. A small amount of HCL sufficient to change hæmoglobin to hematin caused necrosis and ulcers. The presence of HCL alone was not sufficient to cause hæmorrhage or necrosis.

Murdfield (1926) on filling the stomachs of corpses quite early after death with 2–3 litres of weak HCL and subsequently adding a little soda bicarbonate, regularly produced rupture in apparently normal stomachs, of the mucous membrane at least.

In discussing the human cases of spontaneous rupture, we must first of all take into consideration again the question of distention and its effects on the stomach. That distention plays a primary rôle in spontaneous rupture cannot be denied. The mere mechanical factor of acute distention, however, is not sufficient. There are other contributing factors which must be considered. The first question to be asked is, why the overfilled stomach does not empty itself normally before the limits of its elasticity are reached. This may be due to a mechanical or functional obstruction. Passive valve closure in which the overfilled fundus compresses the œsophagus at the cardia (Albrecht and Kelling) and other mechanical factors previously mentioned may take place or failure of the stomach to empty might be purely functional in char-

acter. One can assume a direct influence of the distention upon the nervous mechanism of the gastric wall whereby the nerve endings or the plexus within the wall become paralyzed. The fact that some cases of spontaneous rupture occur in insane might point to the possibility of a central nervous influence. Such a conception finds support in the experiments of Braun and Seidel, who found that in narcotized dogs eructation and vomiting failed to occur even though the stomach was filled to an extreme degree. Nor did it occur when the vagus nerve was cut. From these considerations one can presume that a stomach once overfilled by food which is capable of fermentation will continue to dilate due to the further accumulation of gases and that finally the limitations of elasticity are reached.

On the other hand, the elasticity may be affected by acute local changes within the stomach wall. Distention interferes with the circulation, produces ischemia and the nutrition of the wall suffers. There are a few cases reported of rupture of the stomach with brown softening of the wall which is considered intravital (Leube and Meyer, Kundrat and Froeboese). That such vital autodigestion caused by distention may occur is evidenced by the experiments of Talma. He produced acute distention of the stomach in rabbits by ligation of the duodenum. After sixteen hours the animal was killed. The stomach showed numerous hæmorrhages; in addition, however, a rupture at the greater curvature within an area of brown softening of the wall.

Several of the cases have a history of gastric rupture while attempting to vomit or during the act of vomiting. Bedamie, in 1836, thought that spastic contractions which occur when the stomach is filled ordinarily produce vomiting, but in rare cases cardiospasm prevents this and the wall ruptures. Hutyra and Marek think that rupture often occurs in horses by violent contraction of the gastric musculature with intense increase in intragastric pressure.

A few of the cases give evidence of associated slight pathology. In the case reported by Chiari there is a scar in the wall of the stomach. In Hoffmann's case the stomach showed thick walls. Such observations lead to those cases in which rupture occurs in stomachs affected by ulcer or neoplasm which naturally assume a different aspect.

The cases of Daxenberger, Lantschner, and we might include a case of Rokitansky, are examples of spontaneous rupture of the stomach within a hernia. It is not untenable to believe that some damage may have ensued from this abnormal situation.

The site of rupture is often not specifically localized in the reported cases. But five definitely locate the rent on the lesser curvature. This area has been shown experimentally to be generally the first to give way. Those cases reported of intravital digestion have the rent in a situation other than the lesser curvature, which further substantiates their concept of antemortem digestion.

Subcutaneous emphysema was present in four cases and, as stated, usually occurs in the spontaneous ruptures rather than in those due to severe trauma.

Only two of the cases were operated upon. The one (Versé) in which laparotomy was performed about twenty-four hours after the occurrence of the rupture, died; the other (Steinman) in which operation was done soon after the accident, recovered.

TABLE I.

Severe and Moderate Trauma. Diffuse Injuries.

POLAND: Guys hospital reports, vol. iv, p. 132, 1858. Female, aged nine. Type of trauma.—Run over abdomen by wagon wheel. Symptoms.—Abdomen tender, irritable, restless. Vomited dark material. Signs of external injury.—None. Stomach: size and site of rupture.—Mucous membrane torn and bruised. Internal injuries.—Rupture of liver. Stomach before trauma.—Normal. Procedure and result.—Died, nine hours.

ROCQUES: Soc. de Med. (Poland), 1858. Male, adult. Type of trauma.—Fell from first floor to pavement. Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—Six-inch rent at cardiac end of stomach on greater curvature. Internal injuries.—None mentioned. Procedure and result.—Died, three hours.

COLLINS: Boston Med. Jour., vol. lxxii, p. 202, 1866. Male, aged thirteen. Type of trauma.—After heavy meal fell twelve feet; tree to ground. Symptoms.—Abdominal pain and tenderness. Attempts at vomiting. Signs of external injury.—None. Stomach: size and site of rupture.—Two-inch rent near pylorus, anterior wall. Internal injuries.—None. Stomach before trauma.—Normal. Procedure and result.—Died, nine hours.

BUIST: Amer. Jour. Med. Sci., vol. lx. p. 575, 1870. Male, adult. Type of trauma.—Fell twenty feet, shoulder struck plank ten feet above ground. Symptoms.—Pain in abdomen. Vomited small amount of blood. Signs of external injury.—None. Stomach: size and site of rupture.—Five-inch rent at pylorus extending into duodenum, posterior surface. Internal injuries.—Rupture of spleen. Stomach before trauma.—Normal. Procedure and result.—Died, fourteen hours.

MOXON: Brit. Med. Jour., vol. ii, December, p. 617, 1870. Male, boy. Type of trauma.—Run over by carriage. Symptoms.—Not given. Signs of external injury.—Slight. Stomach: size and site of rupture.—Stomach cut across as by knife. Internal injuries.—Not mentioned. Stomach before trauma.—Normal. Procedure and result.—Not noted.

MURCHISON: Report Path. Soc. London, Brit. Med. Jour. II, 617, 1870. Adult. Type of Trauma.—Train wreck. Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—One and one-quarter-inch rent, knife like, middle of greater curvature. Internal injuries.—Rupture of diaphragm and liver. Procedure and result.—Died, immediate.

LUNN: Trans. Path. Soc. London, Bd. 34, p. 81, 1883. Male, aged four. Type of trauma.—Run over. Symptoms.—Much pain and blood trickled from left nostril. Signs of external injury.—None noted. Stomach: size and site of rupture.—Two complete tears one inch in diameter at commencement of greater curvature. Internal injuries.—None. Stomach before trauma.—Normal. Procedure and result.—Died, four hours.

ERICHSEN'S SURGERY, p. 321.* Male, adult. Type of trauma.—Crushed between wagon and post. Symptoms.—Vomited meal but no blood. Signs of external injury.—None. Stomach: size and site of rupture.—Almost completely across at pylorus. Internal injuries.—Rupture of liver and spleen. Stomach before trauma.—Normal. Procedure and result.—Died, five hours.

ROHNER: Mem. de la Soc. Med. de Nancy Coillot 7, 1879. Male, aged thirty-eight. Type of trauma.—After heavy meal fell from height (twenty metre). Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—Rent on anterior wall near pylorus and lesser curvature. Internal injuries.—Multiple fractures. Stomach before trauma.—Normal. Procedure and result.—Died, five hours.

* Rehn.

STOICESCO: Bull. Soc. Anat. de Par. xlviii, p. 403, 1873. Age not given. Type of trauma.—Fell from considerable height. Symptoms.—Not given. Signs of external injury.—Not noted. Stomach: size and site of rupture.—Rent in anterior wall. Internal injuries.—Rupture of liver, sternum and ribs. Stomach before trauma.—Normal. Procedure and result.—Not noted.

ZIEGLER: Munch. Chir. Klinik. Male, aged twenty-three. Type of trauma.—Crushed between two railroad cars. Symptoms.—Shock, pain, vomiting blood. Later tumor and symptoms of obstruction. Signs of external injury.—None. Stomach: size and site of rupture.—Incomplete, anterior wall (large cyst formed, contained 3 litres dark fluid). Internal injuries.—None. Stomach before trauma.—Normal. Procedure and result.—Operation, three weeks. Recovery.

THIERY: Bull. Soc. Anat. de Paris, vol. lxiv, p. 352, 1889. Type of trauma.—Fell three stories alighting on hip. Signs of external injury.—About pubis. Stomach: size and site of rupture.—One-inch rent along greater curvature in anterior wall. Internal injuries.—Rupture of bladder, fracture os pubis (ramus). Stomach before trauma.—Normal. Procedure and result.—Died, five hours.

WILSON: (Rehn), 1887. Type of trauma.—Run over by wagon wheel. Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—Two-inch rent about two and one-half inches from pylorus, anterior wall. Internal injuries.—Rupture of liver. Procedure and result.—Died, three hours.

ANDREWS: Tr. Glasg. Path. and Clin. Soc., vol. v, 1893. Male, aged seventeen. Type of trauma.—Crushed between cart and wall. Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—One-inch rent two and one-half inches from pylorus, anterior wall. Serosa tear middle anterior wall. Internal injuries.—Rupture of spleen. Stomach before trauma.—Normal. Procedure and result.—Died, eight hours.

REHN: Arch. f. Klin. Chir. Bd. 53, p. 383, 1896. Female, aged nineteen. Type of trauma.—Fell from balcony. Symptoms.—Shock, marked abdominal pain. Vomited blood. Signs of external injury.—Lacerated forehead. Stomach: size and site of rupture.—Three rents, incomplete, one and one-quarter inches, two inches anterior midstomach. One rent posterior. Internal injuries.—Rupture of spleen. Stomach before trauma.—Normal. Procedure and result.—Operation five hours. Recovery.

CLAYTON: Brit. Med. Jour., vol. i, p. 634, 1894. Male, aged sixteen. Type of trauma.—Crushed between buffers of two railroad trucks. Symptoms.—Shock, pain in abdomen. Vomited small amount of blood. Signs of external injury.—Slight abrasion. Stomach: size and site of rupture.—Mucosa torn in two places, midstomach, anterior and opposite posterior. Internal injuries.—Rupture of spleen. Stomach before trauma.—Normal. Procedure and result.—Operation, few hours. Died, twenty-one hours.

ROSE: Freie Vereinigung der Chirurgen, 34–12, 1922. Male, aged twenty. Type of trauma.—Fell from roof, three floors. Symptoms.—Abdominal tenderness and bloody vomitus. Signs of external injury.—None. Stomach: size and site of rupture.—Rent in anterior wall of stomach; adhesion to liver with abscess in left lobe. Internal injuries.—Fracture base of skull. Procedure and result.—Operation in one month. Recovery.

WILDEGASS: Arch. f. Klin. Chir., 122–276, 1922. Male, aged eight. Type of trauma.—Run over by automobile. Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—Rent in pyloric region. Internal injuries.—Rupture of pancreas and liver. Stomach before trauma.—Normal. Procedure and result.—Operation, few hours. Recovery.

NEUBERGER: Wien. Klin. Wochenschrift, 36:849, 1923. Male, adult. Type of trauma.—Fell from great height; landed on face and abdomen. Symptoms.—Shock. Dried blood present about nares. Signs of external injury.—None. Stomach: size and site of rupture.—Rent in prepyloric region, anterior wall and crushing of posterior wall. Internal injuries.—Fracture of right ethmoid retroperitoneal hæmatoma. Stomach before trauma.—Normal. Procedure and result.—Operation nine hours later. Died, twenty-four hours.

MINOR: N. Y. Med. Jour., vol. xlv, p. 360, 1887. Male, aged ten. Type of trauma.—Run over by heavy truck. Symptoms.—Shock, pain region bladder. Vomiting. Frequent desire to urinate. Signs of external injury.—None. Stomach: size and site of rupture.—Rent in lesser curvature. Internal injuries.—Rent in ileum. Stomach before trauma.—Normal. Procedure and result.—Died, twelve hours.

GLASSMAN: Male, aged thirty-three. Type of trauma.—Struck across abdomen by plank. Symptoms.—Shock, rigid abdomen, fluid in flanks. No vomiting. Signs of external injury.—Abrasion skin. Stomach: size and site of rupture.—Four-inch rent in fundus, anterior wall. Internal injuries.—Rupture of spleen. Stomach before trauma.—Normal. Procedure and result.—Operation, three hours. Died, fifteen hours.

TABLE II.

Severe and Moderate Trauma. Localized Type of Injury.

POLAND: Guys Hospital Reports, vol. iv, p. 123, 1858. Male, adult. Type of trauma.—Struck on right side by shaft of dray. Symptoms.—Not mentioned. External injury. None noted. Stomach: size and site of rupture.—Tear in serosa only. Internal injuries.—Rupture of spleen and fracture of two ribs. Stomach before trauma.—Normal. Procedure and result.—Died, eight hours.

POLAND: The same, 1858. Male, aged ninety. Type of trauma.—Maltreated and mauled. Symptoms.—Vomited blood for three days. External injuries.—None. Stomach: size and site of rupture.—Rent size of sixpence on anterior wall. Internal injury.—None. Stomach before trauma.—Normal. Procedure and result.—Died, five days.

PARRY: Austral. Med. Gaz., vol. vii, p. 251, 1888. Male, aged sixty. Type of trauma.—Struck in region of abdomen following explosion. Symptoms.—Marked abdominal pain and thirst. External injuries.—Superficial wounds, fractured hand. Stomach: size and site of rupture.—Four and one-half inch irregular rent on anterior wall. Internal injuries.—None. Stomach before trauma.—Normal. Procedure and result.—Died, four hours.

GROFF: Med. and Surg. Reports, vol. 67, p. 1000, 1892. Male, aged fifty. Type of trauma.—After breakfast, kicked in the abdomen by a horse. Symptoms.—Mild shock, marked abdominal pain. Vomited. External injuries.—Hæmorrhage about umbilicus. Stomach: size and site of rupture.—Two-inch rent near lesser curvature, anterior wall nearer to pylorus. Internal injuries.—None noted. Stomach before trauma.—Normal. Procedure and result.—Died, sixteen hours.

LIMONT and PAGE: Lancet, July 9, 2–84, 1892. Male, aged thirty-one. Type of trauma.—Hard blow in pit of stomach by "bogie." Symptoms.—Pain and vomiting. Stomach: size and site of rupture.—Rent in anterior wall near pylorus. Internal injury.—None. Stomach before trauma.—Normal. Procedure and result.—Spontaneous recovery; resection of scar later.

MARCHETTI: La Clinica, vol. ix, p. 292, 1903. Male, adult. Type of trauma.—Thrown against wooden plank. Symptoms.—Not given. External injury.—None. Stomach: size and site of rupture.—Two-inch rent, pylorus, lesser curvature, posterior wall (irregular rent opposite) directly over vertebra. Internal injury.—Lacerated left rectus muscle. Stomach before trauma.—Normal. Procedure and result.—Operation, ? hours. Recovery.

WEEKS: J.A.M.A., vol. lxvii, p. 1294, 1916. Male, aged thirty-five. Type of trauma.—Steering wheel struck pit of stomach with great force. Symptoms.—Symptom of perforation. External injury.—None. Stomach: size and site of rupture.—Entire thickness at pylorus cut from lesser to greater curvature. Internal injury.—Posterior sheath of rectus lac. Stomach before trauma.—Normal. Procedure and result.—Not given.

IPSON: Norsk. Mag. f. Laegevidensk, vol. 83, p. 514, 1922. Male, aged twenty-three. Type of trauma.—Handle bar of bicycle struck abdomen during collision. Symptoms.—Mild shock, marked abdominal pain. No vomiting. External injury.—Abrasion below

right ribs. Stomach: size and site of rupture.—One cm. rent pars pylorica near greater curvature. Internal injuries.—None. Stomach before trauma.—Normal. Procedure and result.—Operation, few hours. Recovery.

PIANCASTELLO: Riforma Med., vol. 38, p. 1038, 1922. Male. Type of trauma.—Thrown against cart shaft while riding bicycle. External injuries.—Abrasion and contusion, R. U. Q. Stomach: size and site of rupture.—Complete division mid-stomach into two halves, edges regular. Internal injury.—Rupture of recti. Stomach before trauma.—normal. Procedure and result.—Operation. Died, seventeen hours.

ROSE: Deut. Zeitschr. f. Chir. 34, S. 12, 1892. Male, aged twenty-four. Type of Trauma.—Fell and struck left hypochondrium on edge of truck. Symptoms.—Vomited bloody material (later tumor appeared in upper abdomen). External injury.—Contusion. Stomach: size and site of rupture.—Two-inch rent in posterior wall. Internal injury.—Rupture of pancreas. Stomach before trauma.—Normal. Procedure and result.—Operation, fourteen days later. Recovery.

JACKSON: Lancet, vol. i, p. 425, 1884. Male, aged seventeen. Type of trauma.—Emery wheel broke. Large piece struck abdomen. Symptoms.—Collapse, coffee ground vomitus, blood-streaked. External injuries.—Lacerated face, legs and hematoma of scrotum. Stomach: size and site of rupture.—Two rents; two-inch rent pylorus, lesser curvature, posterior wall and one-inch rent (mucosa and serosa only) near pylorus anterior wall. Internal injury.—Blood clots in omental folds. Stomach before trauma.—Normal. Procedure and result.—Died, eight and one-half hours.

TABLE III.

Slight Trauma.

KEY ABERG: Gerichtl. Med. III F. S. 42, 1891. Male, aged fifty-two. Opium user. Nature of trauma.—Stomach lavage following 1 grain of opium. Symptoms.—Symptom of opium poisoning, nausea, cyanosis, coma, reddish fluid from stomach. External injury.—None. Stomach: size and site of rupture.—Several mucosa tears, about ten, in lesser curvature. Stomach at autopsy.—Distended, mucosa injected and flecked with red areas. Internal injuries.—None. Procedure and result.—Died, six hours.

STRAUSSMAN (FRANKEL): Deut. Arch. f. Clin. Med., vol. lxxxix, p. 113, 1906. Male, adult. Opium user. Nature of trauma.—Stomach lavage. Symptoms.—Not given. External injury.—None. Stomach: size and site of rupture.—Lesser curvature, central part about twelve mucosa tears. Internal injuries.—None. Procedure and result.—Died.

REVILLIOD: Revue Med. de la Suisse Romande Nr. 1, vol. 85, ii, p. 193, 1885. Female, aged twenty-eight. Domestic. Nature of trauma.—Fell to the floor. Symptoms.—Abdominal pain, nausea (no vomiting). Subcutaneous emphysema. External injury.—None. Stomach: size and site of rupture.—Three-inch rent, posterior wall, fundus, lesser curvature. Three-inch rent of serosa, centre of anterior wall. Stomach at autopsy.—Markedly distended. Internal injuries.—None. Procedure and result.—Died, two and one-half hours.

MATTIEUX: West. Med. Reporter, Chicago, vol. ix, p. 274, 1887. Female, aged fifty-six. Housewife. Nature of trauma.—Reaching for vessel under bed. Symptoms.—Felt sudden great pain and something give way. External injury.—None. Stomach: size and site of rupture.—Two-inch rent at pylorus. Stomach at autopsy.—Chronic gastritis. Internal injuries.—None. Procedure and result.—Died, third day.

WILSON: Indiana Med. Jour., vol. viii, p. 234, 1889. Female, aged thirty-three. Mother of five. Nature of trauma.—Jumped from high board fence after hearty meal. Symptoms.—Intense abdominal pain, prostration and vomiting. External injury.—None. Stomach: size and site of rupture.—Two-inch rent at pylorus extending into the duodenum. Stomach at autopsy.—Rent easily extended, tissues fragile. Internal injuries.—None. Procedure and result.—Died, eighteen hours.

FARRELL: Lancet, vol. i, p. 1243, 1894. Male, aged thirteen. Schoolboy. Nature of

trauma.—At play with sled after school (had eaten). Symptoms.—Headache, cold feeling, vomited food, convulsions. External injury.—None. Stomach: size and site of rupture.—Three-inch rent on posterior wall. Stomach at autopsy.—Area of inflammation and degeneration of muscle about rent. Rest of stomach healthy. Internal injuries.—None. Procedure and result.—Died, twenty-two hours.

VERSÉ: Munch. Med. Wochnschr. Nr. 46, p. 1290, 1918. Female, aged ten. Imbecile. Nature of trauma.—Slipped and fell on steps; later ate bread, milk, mush. Symptoms.—Abdominal pain, vomited, subcutaneous emphysema (yeast in stomach contents grew 3 mos). External injury.—None. Stomach: size and site of rupture.—Two by two and one-half cm. at fundus, posterior wall. Other tears of serosa. Stomach at autopsy.—Mucosa red. Rent in large red area where serosa is stripped from muscle. Internal injuries.—None. Procedure and result.—Died, eight hours.

GLASSMAN: 1928. Male, aged six. Schoolboy. Nature of trauma.—Stumbled and fell to the sidewalk. Symptoms.—Shock, distention, dulness in flanks, obliterated liver dulness. External injury.—Cut of forehead. Stomach: size and site of rupture.—Three and one-half-inch rent on greater curvature of body and three-quarters-inch rent greater curvature, cardia. Stomach at autopsy.—Diffuse extravasations of blood in submucosa. Internal injuries.—None. Procedure and result.—Operated. Died, six hours.

TABLE IV.

Spontaneous Rupture.

CARSON, J.: Edinb. Med. and Surg. Jour., vol. lxvi, pp. 25–31, 1846. Male, aged twenty. Inciting cause.—Hearty meal. Symptoms.—Mild shock, abdominal pain, tenderness, rigidity, nausea. Stomach: size and site of rupture.—Two and one-half-inch rent in greater curvature. Three inches from œsophagus. Condition stomach post mortem.—Greatly distended. Mucosa of greater curvature injected. Procedure and result.—Died, fifteen hours.

LANTSCHNER: Wiener Med. Blätter, Nr. 4–5, V. J. 81, 1881. Female, aged seventy-two. Inciting cause.—Eight cups water, two cups tea and cold meat. Symptoms.—Sudden "explosion" preceded by nausea and vomiting. Stomach: size and site of rupture.—Four-inch rent on posterior wall, running transversely. Condition stomach post mortem.—Stomach in large umbilical hernia. Procedure and result.—Died, thirteen hours.

CHIARI: Wiener Med. Blatter Nr. 3 d. Aertze Wein, 1881. Female, aged fifty-three. Inciting cause.—Gaseous distention. Symptoms.—Symptom of perforation and subcutaneous emphysema. Stomach: size and site of rupture.—Four-inch rent, middle of lesser curvature through scar of previous ulcer. Condition stomach post mortem.—Markedly distended. Old scar but no sign of ulcer present. Procedure and result.—Died.

HOFFMAN: Virchows Jahresbericht, 1881. Male, aged twenty-four. Inciting cause.—Acute dilatation of the stomach. Symptoms.—Not given. Stomach: size and site of rupture.—Three-inch rent, knife-like, on lesser curvature. Condition stomach post mortem.—Enormously dilated stomach with thickened walls.

MEYER-LEUBE: Zbl. f. klin. Med., p. 81., 1886. Male, aged thirty-seven. Inciting cause.—Much rye bread and young beer full of yeast. Symptoms.—Distention, cyanosis, disappearance liver dulness. Subcutaneous emphysema. Stomach: size and site of rupture.—Four-inch rent in fundus. Condition stomach post mortem.—Mucosa of cardia emphysematous and hæmorrhagic (black) in spots. Procedure and result.—Died, two and one-half hours.

VERSÉ: Munch. Med. Wochenshr. Nr. 46, 1918. Female, aged thirty-two. Inciting cause.—Large meal of cake after diarrhœa for few days. Symptoms.—Pain in epigastrium and cyanosis but no dyspnœa. Stomach: size and site of rupture.—Small rent in centre of necrotic area on anterior surface. Many erosions mucosa. Condition stomach post

mortem.—Stomach dilated to within four inches of symphysis. Procedure and result.—Operation revealed beginning peritonitis. Died, twenty-four hours.

DAXENBERGER: M. m. W., p. 313, 1906. Male, aged twenty-five. Inciting cause.—Acute dilatation of the stomach. Symptoms.—Not noted. Stomach: size and site of rupture.—Rent in fundus. Condition stomach post mortem.—Stomach dilated, in hernia, and has scar at pylorus. Procedure and result.—Died, sixteen hours.

MESNARD: * Female, aged twenty-nine. Inciting cause.—Hearty meal of kraut and fresh pork. Symptoms.—Pain, nausea. Feeling of something give way. Collapse. Stomach: size and site of rupture.—Rents of serosa on lesser curvature. Few mucosa tears of fundus. Condition stomach post mortem.—Not stated. Procedure and result.—Died, nine hours.

NEWMAN, A. J.: * 1868. Male, aged thirty. Inciting cause.—Distention following a meal. Symptoms.—Vomiting, collapse, tympany and subcutaneous emphysema. Stomach: size and site of rupture.—One-half-inch rent about three inches from cardia. Condition stomach post mortem.—Mucosa dark red and walls thin. Procedure and result.—Died, fourteen hours.

STEINMAN: Zbl. f. Chir. S. 181, 1917. Female, aged seventeen. Inciting cause.—Ate large portion of sauer kraut. Symptoms.—Distention, nausea, vomiting. Felt rupture, pain and no more vomiting. Stomach: size and site of rupture.—Three-inch rent on posterior wall running transversely. Condition stomach.—Stomach distended. Edges of wound did not appear pathological. Procedure and result.—Operation. Recovery.

BUSCH: Frankfurt Zeitscht. f. Path., p. 30, 1924. Female, aged forty-seven. Inciting cause.—Three dumplings, two pounds plums, one pound grapes. Symptoms.—Pain, nausea, distention, subcutaneous emphysema. Stomach: size and site of rupture.—One cm. rent, lesser curvature anterior wall. Mucosa tears, anterior wall, lesser curvature. Condition stomach post mortem.—Stomach dilated and areas of hematomata about the rents. Procedure and results.—Died, three and one-half hours.

MURDFIELD: Klin. Wochnscht. (Ab. J.A.M.A. Nov. 13, 1926). Male, aged thirty-nine. Inciting cause.—After much beer and other fluid took little bicarbonate. Symptoms.—Excruciating pain immediately afterward. Stomach: size and site of rupture.—Rent in lesser curvature nearer to cardia. Condition stomach post mortem.—Apparently normal on histological study. Procedure and result.—Died.

KUNDRAT: † 1880. Female, child. Inciting cause.—Hearty meal. Symptoms.—Suddenly seized with abdominal pain. Stomach: size and site of rupture.—Two and one-half-inch rent in fundus, with pulpy appearance. Condition stomach post mortem.—Rent appeared pulpy and surrounded by softening. Procedure and result.—Died in a few hours.

FROBOESE: Med. Klinik, May, p. 494, 1918. Female, aged nineteen. Inciting cause.—Acute distention. Symptoms.—Abdominal pain, tenderness, distention. Two days without food. Stomach: size and site of rupture.—Eight cm. rent in anterior wall near greater curvature. Condition stomach post mortem.—Markedly dilated, with softening and thin walls. No peritonitis. Contained food. Procedure and result.—Died in short time. Autopsy, fifteen hours P.M.

CONCLUSIONS

1. Rupture of the healthy stomach is uncommon. It may be spontaneous or due to severe, moderate or slight trauma.

2. With diffuse (severe and moderate) trauma, other organs are often involved, most often the spleen and liver. External signs of injury are usually not present but occur more often in the localized type of injury. Vomiting is a prominent symptom and hæmatemesis occurs in about 50 per

* Busch, M.: Frankf. Zeitschr. f. Path. 30:30, 1924.

† Hauser, G.: Handb. Path. Anat. u. Hist. Henke u. Lubarsch, iv: 667, 1926.

cent. of the cases. The site of rupture is most often at or near the pylorus.

3. With rupture due to simple or slight trauma there is nearly always a distended stomach which has evidence of disease only in a very small percentage of cases.

4. Spontaneous rupture and that due to slight trauma are closely related as far as their mechanism and the site of rupture are concerned. The underlying causative factors are either purely mechanical (due to distention alone) or combined with acute local changes which constitute an area of least resistance.

5. If rupture of stomach is suspected, laparotomy should be performed early. (X-ray is a valuable aid to diagnosis.) If a rent in the stomach is found at operation, the stomach should be examined for other tears and both liver and spleen should be explored for possible rupture.

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RUPTURED GASTRODUODENAL ULCER

A REPORT OF TWENTY-SEVEN CASES

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The importance of an early and correct diagnosis in ruptured gastroduodenal ulcer has been repeatedly called attention to, in view of the favorable outcome, if treatment is instituted without delay. Because of the acuteness of the condition, the avenues for a correct diagnosis are restricted. At the time of the sudden catastrophe and shortly after, the patients are so sick as to render a comprehensive and intelligent history most difficult. The usual history is that of sudden onset when the stomach is full, with severe, excruciating, tearing pain in the upper abdomen, accompanied by vomiting. There are evidences of shock. Often there is early and partial recovery and the general phenomena associated with the acute catastrophe soon subside, and the signs and symptoms are in the large number of instances localized to the epigastric area.

As a means of early diagnosis, Vaughan and Brams[1] refer to the early recognition of acute perforation by X-ray of spontaneous pneumoperitoneum. In thirteen of their fifteen cases, it was easily and distinctly demonstrated. The free gas has been seen as early as two hours after acute perforation. A small quantity is sufficient for its demonstration. The presence of free air is shown by a distinctly bright zone which shifts on change of posture. The most typical picture is when the patient is upright. The air bubble then assumes a very distinct sickle shape, and disappears on change of posture. It is not necessary, however, to place the patient upright, as a sufficiently characteristic picture may be obtained by placing the patient on his left side, and observing the air bubble between the external abdominal wall and the lateral surface of the liver. The entire procedure may be performed with the screen and with the patient still on the stretcher.

That the air is free may be easily demonstrated by changing the posture when the bubble seeks the uppermost portion of the cavity. The sign is of great value because it makes possible an early and definite diagnosis without danger or discomfort. The examination is easily performed and requires no preliminary preparation.

Recently Vigyzao[2] mentioned the presence of a subcutaneous emphysema as diagnostic of ruptured ulcer. The emphysema is usually localized to the umbilical and cæcal regions. The finding has been corroborated by J. Podlaha,[3] who also reports emphysema of the left supra-clavicular fossa.

In regard to the obliteration of the liver dulness either partially or completely, it is important to point out that too much reliance should not be placed on this sign. A positive finding is of great help, but a negative finding that is the failure of obliteration of liver dulness does not exclude the presence of a perforation. The size of the perforation, the presence or absence of food in the stomach at the time of rupture, the degree of inflammatory reaction around a chronic penetrating ulcer which has perforated will all influence the absence or presence of sufficient air to obliterate any liver dulness.

In perforation of an ulcer at the pylorus or in the duodenum, a plastic exudate may form between the site of perforation and the nearby structures (gall-bladder, liver, omentum, colon), and thus prevent the escape of any air. Our own experience is that this sign (*i.e.* obliteration of liver dulness) is neither early nor helpful. To wait for this finding would be extremely dangerous, for the time element in ruptured ulcer is of the greatest importance. As has been shown repeatedly and as borne out by our experience, the earlier the operation, the greater the possibility for recovery.

The differential diagnosis of ruptured gastroduodenal ulcer, at times, presents difficulties. If the patient has been under medical care for an ulcer, the diagnosis of which has been definitely established, the occurrence of an acute abdominal catastrophe will be readily ascribed to a perforation of the ulcer. However, the onset of severe abdominal pain in adults who have no previous gastric symptoms, does not preclude the probability of a ruptured ulcer as evidenced by certain cases in our report. Nevertheless, a consideration of other conditions which may be responsible for the clinical picture is essential. The classical picture of ruptured ulcer upon physical examination is simulated by very few conditions.

In the consideration of the differential diagnosis, the following conditions present themselves:

1. Gall-bladder disease. (Calculous and non-calculous.) The symptoms of an acute attack are usually preceded by a history of chronic gall-bladder disease. Fever is usually present and jaundice may or may not be an early sign. There is localized tenderness in the right upper quadrant with a distention of the gall-bladder which may be palpable, the liver is enlarged, and there is usually a definite Head zone over this area. The tenderness and rigidity are more localized and if not over the gall-bladder area, is nearby and not diffuse. There is generally an increased amount of bilirubin in the blood (van den Bergh reaction). A history of previous attacks with relief induced by hypodermic injections of morphine sulphate favors the diagnosis of gall-bladder disease. Rupture of the gall-bladder is a rare occurrence and occurs after a lapse of several days following the acute symptoms.

2. Acute pancreatitis quite frequently presents the subjective complaints that closely resemble ruptured ulcer. The excruciating abdominal pain may start in the mid-epigastrium and is bursting or tearing in character. There is frequently a past history of gall-bladder disease. The pain may radiate to both sides but particularly to the left flank or back. Many of the patients are

in complete collapse, cyanotic and present a distinct Malar flush soon after the onset. The abdomen is distended, partly due to fluid and partly due to the distention of the paralyzed ileum as a result of the severe splanchnic shock. Occasionally the impression of a wide bar-like mass may be noted in the epigastrium.

3. Acute perforated appendicitis may produce local and reflex phenomena which may resemble ruptured ulcer. Occasionally, if in an undescended cæcum, an appendix situated rather high up becomes acutely inflamed, and goes rapidly on to gangrene and perforation; there may be a clinical history and findings which closely resemble that of perforated ulcer. Recently one of us, Dr. W. L. W., operated upon a patient in whom an acute inflammation of the appendix had gone on to gangrene and perforated at the cæcal-appendicular margin. There had been a free escape of colon contents, producing a widespread peritonitis with intense peritoneal reaction, marked rigidity of the abdominal muscles and shock.

It is important to realize that in many of the patients with ruptured gastroduodenal ulcer there is definite and marked tenderness in the right lower abdomen. There is a tendency for the contents to gravitate to the right lower abdomen, if rupture occurs when the stomach is full. Early operation should be advised, in a suspicious case, because of the great danger accompanying delay.

4. Intestinal obstruction when situated high up in the small intestine, and if sudden in onset, will produce acute pain. Generally there is severe shock and the persistence of agonizing pain that comes with ruptured ulcer. The vomiting associated with obstruction is persistent at first, bilious and later fecal; the cramps may be rhythmical at definite intervals, and at times one may feel a distended loop. The abdomen is slightly distended rather than scaphoid, and rigidity is not so marked.

5. Diaphragmatic pleurisy may set in with such acute and severe symptoms that the differential diagnosis may present the greatest of difficulties. The board-like rigidity of the abdominal muscles, the pain, and the entire clinical picture taxes the medical ingenuity. If the history of a respiratory infection is obtained, if abdominal reflexes are present, if it is possible to have the patient relax, the abdomen may be then palpated, and if found soft, the probability of a diaphragmatic pleurisy would be more definite.

6. Renal colic is frequently associated with viscero-visceral, viscero-sensory and viscero-motor phenomena. The abdominal rigidity and tenderness are usually associated with some degree of distention. The individual with an attack of renal colic is apt to throw himself restlessly around, whereas in ruptured ulcer, despite the excruciating pain, the individual generally remains quiet. The presence of red blood cells in the urine, the tenderness in the flank, positive Murphy sign and intervals of relief generally indicate renal calculous. In ruptured ulcer there may be slight relief several hours after the acute onset, when the reactionary fluid bathes the entire affected area. In view of the importance of the time element in ruptured ulcer, morphine

should not be given until the diagnosis is established, because of the danger of masking the symptoms and signs.

7. Coronary artery thromboses may closely simulate perforated ulcer. Details are furnished by L. L. Hart[4] of a case where coronary thromboses simulated perforated ulcer. For the past fifteen years, Hart's patient had frequent spells of a hunger sensation in the epigastrium, coming on at about ten A.M., and relieved by a little lunch. A severe attack with rigidity of the abdomen, leucocytoses and elevation of temperature seemed to corroborate the tentative diagnosis of ulcer. Death in twelve days. Necropsy showed no ulcer, but old thromboses of right coronary.

GROUP OF TYPICAL ILLUSTRATIVE CASES

This group of thirteen patients presented a history of gastric symptoms characterized by chronicity and periodicity from one to twelve years.

The ages ranged from twenty-six to fifty-eight years, and the average was forty-two years. Four patients had rupture of a gastric ulcer. In each instance the ulcer was situated on the lesser curvature of the stomach in the region of the pylorus. In nine patients the ulcer was situated on the anterior or superior and lateral surface of the first portion of the duodenum. Four of these thirteen patients had radiographic examinations which confirmed the diagnosis of ulcer prior to the rupture. All gave a history of acute onset with terrific pain localized to the epigastrium. In about one-half the number, there had been a history of greater discomfort than usual after meals, three to seven days before the rupture. In most of these cases the rupture took place while the stomach was full, immediately or one to two hours following a meal.

One patient who had been in the habit of lavaging his stomach had the perforation occur during this process. Another individual with a stenosing duodenal ulcer, perforated a few hours after barium meal.

RUPTURED GASTRODUODENAL ULCER

TYPICAL CASES—ISRAEL ZION HOSPITAL

CASE I.—N. S., age fifty-three, male; admitted August 11, 1925; discharged August 29, 1925; result, recovery; complications, none; occupation, laborer; history, gastrointestinal symptoms for years; onset, twenty-four hours gradual, three hours before admission acute; X-ray, none; operation, one inch from pylorus on stomach side, perforation left anterior.

CASE II.—S. V., age fifty-one, male; admitted February 29, 1925; discharged January 18, 1926; result, recovery; complications, none; occupation, worker; history, five years ago diagnosed as symptoms of ulcer, no trouble until now; onset, one hour before admission severe pain in abdomen; X-ray, none; operation, perforating gastric ulcer near pylorus.

CASE III.—H. N., age forty, male; admitted February 18, 1926; discharged April 7, 1926; result, recovery; complications, lung abscess left pleural effusion, pneumothorax; occupation, operator; history, eight years' recurrent gastric symptoms; onset, supper at

eleven P.M., awakened one A.M. from sleep; X-ray, positive for gastric ulcer; operation, perforating gastric ulcer lesser curvature.

CASE IV.—A. K., age thirty-nine, male; admitted May 12, 1926; discharged June 1, 1926; result, recovery; complications, pneumonia left base; occupation, laborer; history, five years' complaints; onset, two hours before admission acute, severe upper abdominal pain; X-ray, positive for duodenal ulcer; operation, first portion duodenum, small perforation.

CASE V.—O. N., age fifty-eight, male; admitted December 26, 1926; discharged, December 27, 1926; result, died; complication, none; occupation, laborer; history, two years' repeated gastric symptoms; onset, abdominal cramps for one week, ten hours before admission severe cramps below umbilicus; X-ray, none; operation, perforating ulcer first portion duodenum; remarks, week of symptoms of penetrating, perforating ulcer.

CASE VI.—L. F., male; admitted October 27, 1925; result, recovery; complications, pneumonia left lung, abscess (bronchoscopic treatment); history, three years' gastric symptoms; onset, three days before admission severe cramp, admitted to a hospital, left against advice, another severe attack few hours before admission to Israel Zion; X-ray, none; operation, callous ulcer one and one-quarter inches long, second portion of duodenum anterior surface.

CASE VII.—S. Z., age thirty-two, male; admitted August 8, 1927; discharged August 24, 1927; result, recovery; complications, none; occupation, laborer; history, attack 1918, well up to two weeks ago, acute upper abdominal pain three hours before admission, vomiting; onset, sudden; X-ray, none; operation, ruptured ulcer first portion duodenum.

TYPICAL CASES—JEWISH HOSPITAL

CASE I.—R. P., age forty-two, male; admitted November 25, 1920; discharged December 7, 1920; result, recovery; complications, none; occupation, laborer; history, five years' gastric symptoms, pain one to two hours after food; onset, lavaged stomach, had knife-like pains; operation, perforating pyloric ulcer.

CASE II.—F. G., age forty-four, male; admitted March 23, 1921; discharged April 9, 1921; result, recovery; complications, none; occupation, clerk; history, four years' periodicity and chronicity of gastric symptoms one to two hours after food; onset, thirty minutes after every meal; operation, two hours after onset, perforation of ulcer first portion of duodenum; remarks, twenty-five years ago had chancre.

CASE III.—J. A., age twenty-six, male; admitted October 9, 1924; discharged December 5, 1924; result, recovery; complications, pelvic abscess; occupation, laborer; history, gastric symptoms for ten months; onset, six hours before operation, sudden, as if ton of bricks fell on him; operation, perforating anterior surface, first portion duodenum; remarks, second operation for pelvic abscess.

CASE IV.—W. W., age forty-one, male; admitted July 23, 1925; discharged August 7, 1925; result, recovery; complications, none; occupation, laborer; history, periodic and chronic gastric symptoms for ten years; onset, twelve hours after X-ray series sudden pain; X-ray, none; operation, perforating anterior wall, first portion duodenum.

CASE V.—J. B., age fifty, male; admitted March 9, 1926; discharged March 25, 1926; result, recovery; complications, none; occupation, tailor; history, five years' gastric symptoms five to ten minutes after food, pain disappeared spontaneously; onset, three hours before admission pain right lower quadrant; X-ray, positive duodenal ulcer; operation, perforating first portion duodenum with induration.

CASE VI.—I. S., age thirty-three, male; admitted January 26, 1927; discharged February 8, 1927; result, recovery; complications, none; occupation, laborer; history, three years' recurrent pain, two to three hours after food; onset, one to one and one-half hours before admission sudden intense upper abdominal pain; X-ray, none; operation, perforating first portion duodenum; remarks, two weeks prior to rupture, constant pain.

ATYPICAL GROUP

Included in this group of fourteen patients are those without previous history of gastric disturbance.

The history and the onset of acute symptoms and physical findings did not conform with the history and usual findings present in ruptured ulcer. It was interesting to note that in all of these patients as well as in the preceding group, the occupation, with one or two exceptions, was that of a laborer or mechanical operator. The ages varied from twenty to sixty-two years, the average being thirty-seven. All fourteen patients were males and there was but one death in the series. This death was due to an accidental surgical complication. Four of the patients had a perforation of a gastric ulcer situated two or three inches from the pylorus and the remaining ten had a perforated ulcer in the first portion of the duodenum.

The physical appearance of the ulcer in all of the cases with one exception showed evidences of chronic inflammation. In that one instance there was a small perforation in the region of the pylorus with no evidence to suggest a chronic ulcer. The possibility of an acute ulcer going rapidly on from the stage of early mucosal defect to perforation was considered. This patient, a physician, thirty-one years of age, had been perfectly well up to three weeks prior to perforation. A recent radiographic examination of the stomach and duodenum (prior to rupture) had failed to disclose an ulcer defect.

ATYPICAL CASES—ISRAEL ZION HOSPITAL

CASE I.—H. L., age twenty-four; admitted December 17, 1925; discharged December 30, 1925; result, recovery; complications, none; occupation, laborer; history, eighteen hours before operation cramp in right lower quadrant (two A.M.), nausea, constipated; castor oil, followed by vomiting; apparently comfortable, pain only on palpation; operated for acute appendicitis; operation, ruptured ulcer, first portion duodenum.

CASE II.—E. G., age thirty-one; admitted January 28, 1927; discharged, February 10, 1927; result, recovery; complications, none; occupation, physician; history, three weeks before operation belching and epigastric distress after food, evening before operation sudden epigastric pain; operation, ruptured gastric ulcer near pylorus, small perforation; remarks, acute ulcer.

CASE III.—M. E., age thirty; admitted January 29, 1927; discharged February 11, 1927; result, recovery; complications, none; occupation, clerk; history, never ill, sudden acute agonizing epigastric pain after food; vomiting; operation, perforated ulcer first portion duodenum.

CASE IV.—H. F., age sixty-two; admitted May 26, 1927; died; complications, drain loosened, fistula; died seventh day post-operative; occupation, worker; history, well up to four days before onset; for four days distress after food especially, constant pain; operation, perforating anterior wall first duodenum.

CASE V.—F. P., age fifty-five; admitted August 26, 1927; discharged September 12, 1927; result, recovery; complications, none; history, intermittent epigastric pain two to three days, ten hours before admitted intense agonizing epigastric pain; operation, post surface first portion duodenum near pylorus; remarks, obliterated left diaphragm.

CASE VI.—H. S., age forty; admitted October 25, 1927; discharged November 6, 1927; result, recovery; complications, none; history, two A.M., severe epigastric pain, vomiting (two weeks occasional distress two hours after food); operation, perforating ulcer anterior wall first portion of duodenum.

CASE VII.—R. I., age twenty-six; admitted November 18, 1927; discharged December 2, 1927; result, recovery; complications, none; history, three months ago had first symptoms of distress two to three hours after food. Bicarbonate and food relieved pain, one and one-half hours before being admitted excruciating pain, collapse; operation, perforated ulcer anterior wall first duodenum induration.

CASE VIII.—M. S., age twenty; admitted December 24, 1927; discharged, January 14, 1928; result, recovery; complications, none; history, two days ago heartburn and eructations with epigastric pain, day of admission collapsed with epigastric pain, vomiting several times; operation, mid-gastric region, anterior surface, perforating large gastric ulcer, chronic appendix with fecoliths removed at same time; remarks, age, no symptoms.

CASE IX.—C. M., age seventy; admitted May 3, 1928; discharged May 20, 1928; result, recovery; complications, none; occupation, housewife; history, about three years ago began to complain of nausea, cramp-like pains of few minutes' duration located in epigastrium, no relation to meals, frequent hunger pains, vomit occasionally, for past few months apparently normal, suddenly seized with severe pain in right abdomen, vomited once, particles of undigested food, no blood, obliteration of left duodenum; operation, perforated duodenal ulcer.

ATYPICAL CASES—JEWISH HOSPITAL

CASE I.—I. F., age thirty-two, male; admitted May 10, 1920; discharged June 3, 1920; result, recovery; complications, none; occupation, clerk; history, no symptoms until three days ago. Pain gradually worse; operation, perforated pyloric ulcer.

CASE II.—I. F., age thirty-eight, male; admitted April 22, 1924; discharged May 9, 1924; result, recovery; complications, none; occupation, driver; history, ten hours before admitted while at work sudden epigastric pain, no obliteration of left duodenum; operation, perforated ulcer first portion duodenum, superior anterior surface.

CASE III.—A. B., age forty-four, male; admitted March 30, 1925; discharged April 13, 1925; result, recovery; complications, none; occupation, bricklayer; history, twelve hours before admitted mild epigastric pain, gradually worse, more severe six hours before admitted; operation, perforating gastric ulcer near pylorus, anterior surface.

CASE IV.—W. S., age twenty-nine, male; admitted July 12, 1925; discharged August 7, 1925; result, recovery; complications, broncho-pneumonia; occupation, laborer; history, thirteen hours before admitted mild abdominal pain, four hours before went to toilet, strained, sudden epigastric pain; operation, perforated ulcer first duodenum.

CASE V.—N. S., age thirty-two, male; admitted March 13, 1925; discharged March 28, 1925; result, recovery; complications, none; occupation, stationery store; history, for five weeks epigastric pain after food, two hours before admitted excruciating pain in lower abdomen; operation, perforated ulcer first portion duodenum.

CASE VI.—C. S., age forty-four, male; admitted March 30, 1926; discharged April 13, 1926; result, recovery; complications, none; occupation, laborer; history, four hours before admitted on arising from bed had sudden excruciating pain in right upper abdomen; operation, perforated ulcer first portion duodenum.

COMMENT

1. Perforation may occur in young as well as old people. Its greatest frequency, however, is in middle-age, during the period of greatest physical activity.

2. Almost half of the patients in our series presented either symptoms or physical findings which did not conform with the usual and accepted signs and symptoms present in such a calamity.

3. In this series two patients out of twenty-seven died; one death followed an accidental surgical complication, and the other was due to general lowered resistance and an extensive peritonitis, because of delay in reaching the hospital. As has been so frequently stressed in previous communications, any patient should be operated upon immediately after rupture, and recovery generally follows.

4. Inspection of the site of perforation revealed evidences of chronic inflammation in all of the patients with one exception. Absence of evidence of chronic inflammation, the small size of the perforation, and the softness of the tissue appeared to point to an acute ulcer which had rapidly gone on to rupture.

5. The differential diagnosis may present many problems, particularly in view of the difference in the reactions individuals have normally to pain sensations. In any suspected case, hospitalization should be demanded.

ADDENDUM

Since this report has been forwarded for publication there has been added a report of one more patient.

This record, Case IX, in the Atypical Group, presents a history of ruptured duodenal ulcer, with recovery, in a woman seventy years old, who had seldom complained in her past life.

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MYOMA OF THE APPENDIX*

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Although there is much more striated muscle in the human body than smooth muscle, tumors of striated muscle are much rarer than tumors of

Table I

Case No.	Author	Date	Sex	Age	How Found	Clinical Note	Nature of Tumor
1	Lafforgue[5]	1893	♀	52	not mentioned	none given	Three small submucous fibromyomata, one pedunculated.
2	Rosi[6]	1897	♂	56	operation	Pain in inguinal region and diarrhea for twenty years.	Myoma 9.6 cm. in diameter in inguinal hernia sac.
3	Steiner[7]	1898	♀	20	autopsy	Found at autopsy following death from brain tumor. No appendix symptoms.	Fibromyoma, 3 x 2½ cm., at base of appendix.
4	Kelley[8]	1900	♀	not given	operation	Appendix removed with uterus which contained fibromyomata.	Two fibromyomata of appendix, each 5 mm. in diam., and one having calcareous deposits.
5	Kelley[8]	1900	not given	not given	not mentioned	none given	Single fibromyomatous nodule.
6	Hayem[9]						Fibromyoma of appendix.
7	Corner[10]	1909	♂	23	operation	History of two attacks of acute appendicitis. Interim removal.	Small rounded submucous fibromyoma of distal end.
8	Stickney[11]	1915	♀	39	operation	Symptoms of chronic appendicitis for one year.	Clubbed appendix tip containing five small myomata, the largest 3.5 mm. in diam.
9	Redway[12]	1917	♀	36	operation	Pain in right lower quadrant of five months' duration.	Fibromyoma of distal end, small.
10	Redway[12]	1917	♀	40	operation	Uterus, tubes, one ovary and appendix removed for general pelvic inflammation.	Fibromyoma of distal end, small multiple fibromas of uterus also.
11	Podesta and Pividal[13]	1923	♀	Child-bearing-Age	operation	Attacks simulating appendicitis.	Fibromyoma—external —size of hazelnut.
12	Leorat[14]	1924	♂	39	operation	Acute appendicitis with perforation at base.	Fibromyoma size of cherry at tip of appendix.
13	Lillie and Parcher[15]	1927	♂	40	operation	Abdominal pain and distress for 6 or 7 yrs. Operation revealed adhesions about gallbladder, pylorus and appendix.	Three submucous myomata, each 5 mm. in diameter.
14	Koontz	1928	♀	26	operation	Symptoms simulating chronic appendicitis.	Diffuse fibromyoma of tip of appendix.

* Read before the Medical and Chirurgical Faculty of Maryland, April 25, 1928.

smooth muscle. Myomata of striated muscle (rhabdomyomata) are indeed rare occurrences, while among myomata of smooth muscle (leiomyomata) are to be found what Adami [1] calls the commonest of all tumors—the fibromyomata of the uterus. The next most common site of the leiomyoma is, according to Adami,[1] the non-striated coats of the gastro-intestinal tract. However, the digestive tract as a site for the development of myomata is a very poor second to the uterus. Steiner,[2] who wrote an exhaustive paper on the subject in 1898, was able to collect only fifty-one cases.

Considering the small number of myomata found in the entire gastro-intestinal tract, the appendix probably comes in for more than its proper proportionate share. This share, however, is not large. Kelly,[3] in 1909, stated that there were only three cases of myoma of the appendix recorded. Dandy,[4] in 1914, could find in the literature only ten cases of benign tumors of the appendix of all sorts, and the case he reported—that of a myxoma of the appendix from Halsted's clinic—was the first case of benign tumor of the appendix among the several thousand specimens in Doctor Bloodgood's pathological section of the surgical clinic of the Johns Hopkins Hospital. The number of reported cases of myoma of the appendix has now increased to thirteen. A brief summary of these cases is shown in Table I. I wish to add another case to those already reported.

FIG. 1.—Gross appearance of specimen showing large bulbous tip of the appendix.

CASE I.—K. B., an unmarried white female, aged twenty-six, had been troubled with pain in the epigastrium, right upper abdominal quadrant and umbilical region for a period of three months. There was associated constipation. The pain was cramp-like in character and gradually became localized at McBurney's point.

Abdominal examination was negative except for considerable tenderness at McBurney's point. The leucocyte count was normal.

Appendectomy was performed through a right rectus incision November 23, 1921. The pelvic organs and abdominal organs other than the appendix were normal. The appendix was bound down behind the cæcum, the proximal part atrophic, the distal end enlarged and bulbous (Fig. 1). On opening the appendix the lumen of the proximal portion was found to be obliterated, while the wall of the distal portion was very thick and fibrous, suggesting a long period of chronic inflammation. Microscopic sections (Fig. 2) showed that we were dealing with a fibromyoma.

The patient was seen on March 30, 1928, and stated that there had never been any recurrence of her symptoms. She is now married and has two children.

A study of the reported cases of myoma of the appendix shows that about half of them presented symptoms suggestive of appendicitis, and were operated upon because of these symptoms. The rest were accidental findings at operations for other conditions, or at autopsy. Most of the tumors were small, but the sizes ranged from tumors a few millimeters in diameter to one 9.6 cm. in diameter. This unusually large one (Rosi) was found in an inguinal hernia sac, and its nature was not suspected until herniotomy was performed. In none of the other reported cases could the tumor have been palpated through the abdominal wall. In no case was the diagnosis made before operation or autopsy.

FIG. 2.—Microscopic section of tumor.

Eight of the cases occurred in women, four in men, and in two the sex was not mentioned. The youngest case was twenty years of age and the oldest fifty-six.

In only three of the cases (Rosi, Stickney, Lillie and Parcher) were the tumors pure myomata. All the rest were fibromyomata. Ewing[16] states that "according to Boetticher and Lode three types of intestinal myomas may be distinguished: (1) Small multiple nodular or polypoid tumors arise from local proliferations in the muscularis, the mucosa is free; (2) broad thick tumor masses form in the muscle layers, while the mucosa becomes adherent to the tumor; (3) large polypoid subserous myomas may project into the peritoneum." The same classification, with certain modifications, holds, as would be expected, for the reported cases of myoma of the appendix. The author's case was of the broad diffuse type originating from all the muscle layers, which Boettcher[17] calls a composite myoma.

The interesting group of endometrial implantation "adenomyomata" of the appendix have not been included in this report as they are not primary tumors of the appendix, and are not true myomata. Dougal,[18] Suzuki,[19] and Seelig[20] have recently reported cases of these implantations. Seelig states that his case is the sixth recorded case. Sampson[21] in 1921 showed that implantation "adenomyomata" develop as a result of the rupture of chocolate cysts of the ovary, which are lined by endometrial tissue; and in 1922[22]

he put forward the hypothesis that the endometrium gets into the ovaries by escaping from the fimbriated ends of the fallopian tubes, due to an abnormal menstruation with a back flow.

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PRIMARY CARCINOMA OF THE VERMIFORM APPENDIX

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A review of the literature to find the first report of an authentic case of carcinoma of the appendix has produced some very interesting results. Not a few authors have written about this supposedly rare condition. Invariably, with one exception, Merling, *Journal de l'Experience*, 1838, is given credit for the original case report—or at least for the first reference to carcinoma of the appendix.

There was created, therefore, the desire to see and perhaps extract Merling's report. No difficulty was experienced in locating at the New York Academy of Medicine the *Journal de l'Experience*, 1838. An accurate translation, however, failed to mention any reference whatever to carcinoma. To prevent the possibility of an error, the article was read aloud to me. At no time is the word carcinoma used. Merling discusses the anatomy of the appendix and a variety of diseases affecting it. To quote from the article: "At an autopsy the walls of the vermiform appendix were gray brown, scirrhous, as if formed by small hard tumors. Near the cæcum the appendix presented a round opening the size of a pea with hard and unequal edges." This description hardly warrants the diagnosis of carcinoma. Yet it is the only point of Merling's thesis that even mentions the word tumor. It is reasonable, therefore, to conclude that he did not report the first case of carcinoma of the appendix.

According to the literature, Crouzet[5] reported the second case of carcinoma of the appendix. This was in 1865, twenty-seven years after Merling's report. What he really reported was a soft, sessile, hæmorrhagic tumor of undetermined etiology. There is no reason to suspect or to think that he was describing a case of carcinoma of the appendix.

The following year, 1866, Rokitansky[22] reported four cases of carcinoma of the appendix. The description of the cases, together with the lack of pathological evidence, does not warrant such a diagnosis.

Kolaczeks[10] in 1875 described unquestionably a case of carcinoma, but it involved the cæcum, not the appendix. Leichenstein in 1876 and Bierhoff in 1880 both described cancer of the appendix. Unfortunately, however, these are not admissible for they were secondary cases and not primary in the appendix.

It was not until 1882 that Beger[2] described and reported the first unquestionable case of primary carcinoma of the appendix. He does not claim that his is the first case. He does state that "carcinoma of the appendix

is rare." No doubt he had in mind the cases of supposed similarity previously reported.

The importance of carcinoma of the appendix was first emphasized in 1903, exactly twenty-one years after the first authentic report by Beger. In that year, Elting [7] and Moschkowitz [15] each published in the ANNALS OF SURGERY articles describing this condition and reporting, after careful search of the literature, only forty in the case of the former and eighteen in the case of the latter. In 1906, twenty-four years after the original description, only forty-two cases had been reported. Twenty-eight of these were by American authors.

As time rolled on patients accumulated more money, hospitals became better endowed, and pathological service was better grounded. This resulted in the examination of more of the specimens removed at operation. Finally most specimens removed were examined, and this resulted in the discovery of many cases of cancer of the appendix. In the light of subsequent events, largely brought about by the routine examination of all specimens removed at operation, carcinoma of the appendix has been re-discovered many times. The condition, therefore, is no longer a rarity.

Sporadic cases have been not infrequently reported, and from time to time the literature has been brought up to date. The most recent treatise, that by Van Alstine,[25] reports two additional cases and collects in all about three hundred case reports to that date—June, 1926. It is exhaustive and leaves little to be said. Since then two additional cases have been reported —one by Loe in February, 1927, and one by Walker in April, 1927.

In this article I shall add thirty-four new cases to the literature—none of which has previously been reported. The operations were all performed at the Post-Graduate Hospital, New York City, on the combined services of the several attending and associate attending surgeons. I am indebted to these men for permission to report their respective cases.

By comparison with the total number reported to date, it would appear that the Post-Graduate Hospital has had more than its share. But according to the law of averages, this is an unreasonable conclusion. That the pathological examinations at the Post-Graduate Hospital are superior to those elsewhere is also an unreasonable conclusion. One must assume, therefore, that there is a great laxity in reporting this interesting condition; due, perhaps, to the fact that all specimens are not sent for pathological examination. Furthermore, since the condition is never diagnosed previous to operation and is practically always benign, the attitude toward it seems purely academic.

The series of cases herein reported has been collected from a review of specimens examined at the Post-Graduate Hospital during the past eight years. There were 45,302 pathological specimens in all, thirty-four of which showed malignant disease of the appendix. This incidence, therefore, is .075 per cent. of all specimens examined. Of appendices examined, the incidence is .35 per cent., which figure closely approximates that reported by numerous observers, including Reiman,[19] Meyer,[16] and McWilliams.[14]

The average age in this series was thirty-four years—the youngest patient being eighteen years and the oldest sixty-seven years. This, too, is in close accord with most of the previous reports, which, summed up, state that the disease occurs most often in the third decade.

As a matter of interest, there were selected two hundred consecutive patients from whom the appendix had been removed, either alone or in conjunction with more important surgery. The average age in this series was thirty-five years minus—almost exactly the same as in the series of carcinoma cases. It would appear, therefore, that the age incidence is of absolutely no importance, the average being the same in those with or without cancer.

The youngest recorded case is one reported by MacCarty and McGrath [13] in a child of five years; the oldest recorded case is one reported by Rogg [21] in a patient of eighty-one years.

The question of sex in this series is particularly interesting because of the great preponderance of females afflicted. McWilliams, in a collected series of seventy-seven cases of primary carcinoma of the appendix, reports forty-four, or 57 per cent., in females. Primrose,[18] quoting Boyer,[3] gives from 60 per cent. to 70 per cent. in females; Reiman [19] states: "It occurs more commonly in the female." In the present series of thirty-four cases, twenty-eight, or 82.4 per cent. occurred in the female. Compared with the other averages, this is unusually high. The Post-Graduate is not particularly a hospital for women; in fact it has a larger number of beds for male patients, and the turnover is greater on the male than on the female division.

Of the two hundred consecutive operations referred to above, where the appendix had been removed, exactly one hundred and fifty, or 75 per cent., were female. The opinion of several busy operators, expressed verbally, is that the female abdomen is subject to more surgery than the male abdomen, which in turn would account for more routine appendectomies. With a larger number of female appendices to examine, it is logical that the greater number of carcinomas should be reported as occurring in that sex.

Nevertheless, 82.4 per cent., as reported in this series, is very high. Taken together with reports of other observers, one could fairly deduce that the condition is more common in the female. Rolleston and Jones [23] state that the disease does not affect the female more often than the male.

In seventeen cases of the series, the operation was performed for colelithiasis, gastric ulcer, or fibroid uterus, and the appendix removed incidentally. In ten cases the operation was performed for acute—acute gangrenous or acute purulent—appendicitis and the cancer was discovered incidentally. In two cases the operation was performed for hernia—one umbilical, one inguinal—and the appendix removed incidentally. In five cases the operation was performed for chronic appendicitis. These facts do nothing but emphasize the casual, accidental finding of the condition. At no time, as far as the records show, was carcinoma diagnosed or suspected.

All cases were primary in the appendix and situated as follows: twenty-eight at the tip, five at the base, and one midway between tip and base. Of

the five at the base, one had penetrated the serosa, and one had metastasized to the meso-appendix. In all five a warning of the likelihood of recurrence was issued by the pathologist. They were of the columnar-cell type. The possibility of metastasis, therefore, is slight—less than .6 of 1 per cent. in this series. Even this small percentage is important, and stresses the necessity of always removing the appendix, barring contraindications, whenever the abdomen is opened.

There are two general types of cancer that involve the appendix. The first is the columnar-cell or gelatinous adenocarcinoma. This tumor does not differ from the same type of growth found elsewhere in the abdomen. It is ordinarily not found in early life and is very prone to recur. The second type is composed of small polygonal or spheroidal cells. It may occur at any age and is nearly always benign.

In the past the majority opinion has been that even though these tumors vary slightly from the usual run of carcinomas, they should be classed as such. The name carcinoid has been coined to indicate its association with carcinomas and still differentiate it from them. Other names by which it has been christened are—benign cancer, pseudo-carcinoma, and chronic hyperplastic lymphangitis. An exhaustive review of the literature, including the study of not less than eighteen articles in a variety of languages by as many authors, embracing Perret,[17] Warwick,[26] Elting,[7] Luce,[12] Deaver,[6] Reiman,[19] McWilliams[14] MacCarty and McGrath,[13] Moschkowitz,[15] Rogers,[20] Van Alstine,[25] Meyer,[16] Rogg,[21] Adami,[1] Harte,[8] Kelly,[9] Tate,[24] and others, failed to give any clue to its origin.

Primrose reports two remarkable cases of carcinoma of the appendix occurring in sisters, both of whom suffered from tuberculosis. Aided and abetted by quotations from numerous authors, he draws an excellent case for the close association as to the causative agent (except for the tubercle bacillus itself) in cases of tuberculosis in and about the appendix and carcinoma of the appendix. He also brings forward for consideration, as does Child[4] and Le Conte,[11] the possibility of heredity as a cause.

There are present excellent possibilities to fit all theories of cancer of the appendix. Being subject to all ordinary infections and having low resistance, it could carry off the honors for those who favor the infection theory. Since it is endowed with a poor blood supply, it has gained favor with the adherents of the nutritional theory. Its vestigial origin—being formed by a budding process—gives heart to the members of the biological theory.

P. Masson has carried his investigation further and has recently more forcibly stated his theory as to the origin of these tumors. To quote him: "Carcinoids result from proliferation of intra-nervous argentaffin cells of the neurocrine type. They pile up in the nerve fibres, finally rupture their sheaths, and infiltrate the intestinal tissue of the neuroma and then that of the submucosa." This is the latest word as to the cause of this interesting condition.

The search for a sufficient number of signs or symptoms upon which to base even a tentative diagnosis has borne no results. After carefully weighing all the evidence at hand, including the histories of the thirty-four cases herein reported, one can reach no conclusion nor can one make a definite, positive statement regarding a single symptom, or a chain of symptoms, that would assist in making a diagnosis of cancer of the appendix. Even if a tumor in this region were palpated—and this is quite possible—to say that it is a tumor of the appendix would not be much more than a guess.

It would seem that we are still in the dark as far as a diagnosis of this condition is concerned. In ninety-nine cases out of the next one hundred, the operator will be surprised when the pathologist reports that the appendix removed shows a carcinoma, or carcinoid, at the tip, adding a note that these tumors are generally benign and need give no concern unless they happen to be located at the base.

SUMMARY

1. Carcinoma of the appendix is a distinct pathological entity.
2. The first authentic case was reported by Beger in 1882.
3. It is not a rarity.
4. Its incidence is approximately one-half of 1 per cent. of all appendices removed.
5. It is discovered most frequently in the third decade; the usual appendectomy—for appendicitis or of a prophylactic nature—is also performed in the third decade.
6. It will probably be discovered more often in the future.
7. More than 75 per cent. of the cases occur in the female. This is of no special significance, since the female abdomen is more subject to surgery than the male and the appendix more often removed.
8. It occurs most often at the tip and is nearly always benign.
9. P. Masson has written the latest word as to its etiology in the May, 1928, issue of *American Journal of Pathology*.
10. It has never been clinically diagnosed.
11. It produces no signs or symptoms of sufficient distinction to warrant a pre-operative diagnosis.

Acknowledgment is made for use of the files and records of the Department of Laboratories, New York Post-Graduate Medical School and Hospital.

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APPENDECTOMY WOUND REPAIR AND HERNIA *

By John H. Garlock, M.D.
of New York, N. Y.

Up to about January, 1921, there was a fairly definite routine on this service for the treatment of acute appendicitis. This embodied a number of principles suggested by Doctor Pool. All patients were operated upon by members of the staff of the Second Surgical Division. The McBurney incision was used in the majority of cases. Whenever any doubt existed as to the diagnosis, especially in females, a right rectus incision was made. The stump of the appendix was inverted when possible and covered with a purse string suture reinforced by a Lembert suture, both of catgut. The stump was ligated and cauterized in the presence of induration in the cæcal wall. When a large incision was necessary, partial suture of the aponeurosis was done, thereby burying foreign material and interfering with the blood supply of a tissue easily subject to bacterial infection. When drainage was indicated, two cigarette drains were used, the longer one placed directly to the area to be drained, and the shorter just into the peritoneal cavity, but not to the focus. The short drain was removed at the end of twenty-four hours, and the long one loosened, with the hope that drainage would take place around the cigarette rather than through it. When suppuration was profuse, the long drain was removed in from forty-eight to sixty hours after operation, and a tube inserted. The members of this staff feel convinced that fewer fæcal fistulæ occur with this method than when tubes are inserted at the time of operation. Drainage is employed when there is pus or when oozing is likely to occur.

During the years up to about 1921, a rather frequent finding post-operatively was necrosis and sloughing of the fascia in the wound. It was felt that this tended to increase the incidence of post-operative hernia. About this time, a change in the routine treatment of the wound was instituted by Doctor Pool, and this has been followed practically in every instance to date. In all cases of acute appendicitis where the diagnosis is certain, the McBurney incision is used. In making the intermuscular incision, an effort has been made not to hamper proper exposure by the small size of the opening. In other words, whenever necessary, the incisions have been generous. In general, after removal of the appendix, the stump is inverted. Induration of the cæcum, inaccessibility, and friability of the tissues are indications for simple ligation of the appendix stump. When drainage is indicated, one cigarette drain is placed near the stump of the appendix and another is

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inserted through the peritoneum. The latter is so placed, that, upon its removal, a wider drainage tract will result. It is usually removed in twenty-four hours. The deeper one is shortened gradually until its complete removal after forty-eight to sixty hours. When the discharge is profuse, it is replaced by a soft rubber tube. When the drainage tract becomes more superficial, the Carrel-Dakin treatment is instituted. When necessary, additional drains are placed to the pelvis or the right lumbar gutter at operation. These are gradually shortened. In most drained cases, especially when *B. coli communis* is obviously present, *the wounds are left wide open.* Very often, to prevent prolapse of bowel or omentum, a few sutures of plain catgut are placed in the parietal peritoneum. No sutures are placed in muscle, fascia or skin.

We have been greatly impressed with the change in the appearance of these wounds post-operatively. Whereas formerly fascial slough with its characteristic odor and suppuration was encountered frequently, it has been an infrequent finding since the adoption of this method of treating these wounds.

Fascial slough and wound infection following the operation for acute appendicitis with drainage may have two causes. It may be due to the use of sutures in the fascia, causing tissue necrosis of a structure susceptible to infection, or it may be due to the presence of anaërobic organisms. The few anaërobic cultures that we have made have been inconclusive. It is a subject that deserves further study. To prevent, therefore, tissue necrosis and the growth of anaërobes these wounds are left wide open whenever possible. A thin layer of vaseline gauze is placed over the skin edges to render the first dressing painless.

While the above has been the recognized routine since 1921, it was not used in every case, and there is now presented the unusual opportunity of comparing two series of cases. In one, no sutures were used. In the other, sutures were placed in either the fascia or skin or both. In addition, there is for study a series of right rectus incisions.

Of the total series of 755 cases of acute appendicitis, there were forty-seven deaths, or 6.2 per cent. Table I indicates the mortality by decades.

TABLE I.

Mortality by Decades.

Age	Cases	Deaths	Mortality per cent.
From 0 to 10	107	9	8.4
From 11 to 20	274	8	2.9
From 21 to 30	177	9	5.0
From 31 to 40	112	6	5.3
From 41 to 50	50	6	12.0
From 51 to 80	35	9	25.7

A glance at Table II discloses the fact that the majority of the deaths were due to peritonitis, present at the time of operation. In the group of 236 cases labelled as closed without drainage there was no mortality.

TABLE II.

Causes of Death in Forty-seven Cases.

	Cases	Per cent.
Diffuse peritonitis	33	70.2
Abscess	1	2.1
Abscess with peritonitis	5	10.6
Embolism	2	4.2
Pneumonia	2	4.2
Pylephlebitis	1	2.1
Sepsis	2	4.2
Myocarditis	1	2.1

For purposes of careful comparative follow-up study, these cases have been grouped as follows:

Group I.—Cases drained without sutures in fascia or skin.
Group II.—Cases drained with sutures in fascia or skin or both.
Group III.—Cases with right rectus incisions.
Group IV.—Cases closed without drainage.

Group I.—(Cases drained without sutures in fascia or skin.) In this group there were 290 patients. Twenty-six were lost from follow-up, leaving 264 for actual study. During convalescence, five were noted as having fascial slough. All these patients in all groups were followed from three to twenty-four months, some for thirty-six months. The average was twenty-two months. At follow-up examination, a number of patients were found to present a hiatus in the external oblique aponeurosis with an otherwise firm wound. There were twenty-eight such cases and they were followed carefully. Of these, two subsequently developed herniæ. In the entire group of 264 followed cases, seventeen developed a hernia in the scar, a percentage of 6.4. Table III shows the distribution according to decades.

TABLE III.

Age Incidence of Hernia in Group I.

Age	Hernia
From 0 to 10	0
From 11 to 20	2
From 21 to 30	2
From 31 to 40	5
From 41 to 50	5
From 51 to 80	3
Total	17

or 6.4 per cent. for Group I.

This is to be compared with the findings of Bancroft, who reported a series of cases from the same service in 1920. His paper, which included

a series of 584 consecutive cases of acute appendicitis, embodied an analysis of the mortality rate, the incidence of post-operative complications, a description of the pathology found at operation, and an enumeration of the data obtained at frequent follow-up examinations. In 295 drained cases that were followed carefully for approximately the same period as noted above after discharge from the hospital, there was an incidence of forty-five herniæ, or 15 per cent. All the patients in this group were treated according to the routine in use at that time.

Group II.—(Cases drained with sutures in fascia or skin or both.) There were 124 patients in this group. Twenty were lost from follow-up, leaving 104 for study. Two were noted as having fascial slough during convalescence. A dehiscence in the external oblique fascia was noted in eight cases on follow-up examination. In the total group of 104 followed cases, twelve developed post-operative ventral herniæ, or 11.5 per cent. The decade distribution of these cases is shown in Table IV.

TABLE IV.

Age Incidence of Hernia in Group II.

Age	Hernia
From 0 to 10	1
From 11 to 20	2
From 21 to 30	2
From 31 to 40	4
From 41 to 50	3
From 51 to 80	0
Total	12

or 11.5 per cent. for Group II.

Group III.—(Cases with right rectus incisions.) There were fifty-eight patients who had right rectus incisions. Of these, fifty were actually followed. Eight patients subsequently developed ventral herniæ, a percentage of 16.

Group IV.—(Cases closed without drainage.) In this group, there were 236 patients with no post-operative mortality. Of 216 followed cases, there was no instance of hernia.

Fæcal Fistula.—While, undoubtedly, a number of factors play a rôle in the development of fæcal fistula after the operation for acute appendicitis, we have always felt that one of the most important is the type of material used for drainage purposes. With induration of the cæcal wall, interference with circulation due to local thrombosis, operative trauma, friability of the tissues and slipping of a ligature from the base of the appendix, acting singly or combined, constituting the important predisposing causes, the final local insult is administered with the introduction of some form of rigid drainage material. It is a surprising fact that glass tubes are being used in one or two of the large clinics in this country. Many clinics use, as routine, large rubber tubes of great rigidity. It has been routine on this service to use carefully made cigarette drains. We hope to drain around the cigarette and

not through it. It is the softest type of drain at our command and will cause least pressure necrosis. That it acts effectively is evidenced by our decrease in post-operative secondary abscesses.

The diagnosis of fæcal fistula is made on the discharge of fæces from the wound and always is verified by the administration of methylene blue by mouth. In this series of 472 drained cases, there were twelve fæcal fistulæ, a percentage of 2.5. Nine of these closed spontaneously and three required operative repair.

CONCLUSIONS

1. The only hope of reducing the mortality rate of acute appendicitis lies in early diagnosis, and early operation. In the undrained cases reported in this series there was no death.

2. The most common cause of death is diffuse peritonitis. Of forty-seven deaths in this series, 70 per cent. were due to this cause.

3. The highest mortality rate occurs in the first, fifth, and later decades.

4. The incidence of fæcal fistula may be greatly reduced by the employment of an atraumatic operative technic and the use of soft drainage material. In 472 drained cases, there were twelve fæcal fistulæ. Nine of these fistulæ closed spontaneously.

5. The number of post-operative ventral herniæ has been reduced more than half since the practice of avoiding the placing of sutures in muscles, fascia, or skin was adopted. In a group of 264 followed cases, seventeen developed a hernia, a percentage of 6.4. In contrast to this, is a series of 295 drained cases from this service, reported in 1920, with forty-five herniæ, or 15 per cent.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD APRIL 25, 1928

The Vice-President, Dr. Edwin Beer, in the Chair

CONGENITAL WEBBED FINGERS

Dr. Kirby Dwight presented an eight-year-old boy with congenital webbed finger—third and fourth fingers of each hand. On the left side the webbing extended only to the base of the second phalanx and had been operated upon previously, apparently by a simple splitting of the web. On the right side the webbing extended clear down to the tip of the finger and the tips of the distal phalanges were joined together by bony union.

The right hand was operated upon at Lincoln Hospital, November 4, 1927. The commissure between the fingers was formed by using Felizet flaps and then, distal to the site where these flaps were taken a modified Didot operation was done. The terminal phalanges were separated with a chisel. December 14 a similar operation was done on the left hand and the scar tissue of the previous operation was excised. January 30 a partial ostectomy of the distal end of the second phalanx of the right middle finger was done similar to a bunion operation. Its purpose was to correct the lateral angulation of the distal phalanx, caused by a difference in the rate of growth of the two fingers while their tips were fused together. These wounds all healed kindly, the raw areas quickly being covered with epithelium.

At the time of operation the commissure on both hands was made higher, (that is the fingers were split further), than the commissure between the other fingers. At the present time the result is moderately satisfactory. The webbing has recurred to a certain extent in spite of the fact that a good commissure was obtained on both sides. This recurrence, he believed, is due to the contraction of the scar tissue along the fingers. It was his impression that there is less likelihood of this recurrence if the Didot operation is done without using skin from the fingers to form a flap in the commissure. However, in any case with children, it is likely that with the growth of the fingers the web would be drawn down somewhat, as the scar tissue would not stretch as the fingers grew. This case was shown as an example of the fact that there may be a partial recurrence of the web even though a good commissure has been constructed.

Dr. Carl G. Burdick said that many years ago Doctor Downes taught him a method for operating on webbed fingers which he had always followed. A triangular flap is taken from the dorsum of the web with the base over the heads of the metacarpals, a vertical incision made on the anterior surface of the flap, the triangle turned in and the apex sutured in front. The denuded areas on either side of the flap are immediately skin grafted.

There have been a number of cases of webbed fingers in the speaker's service at Bellevue Hospital and none have recurred.

Dr. Winfield Scott Schley said he had tried all known methods of

operation for this condition. In the last analysis it is a skin graft pure and simple. The incision separating the fingers must be carried well down to between the heads of the metacarpals. The grafts have to be kept down to the very bottom, and are held there for six to seven days and then are carefully dressed. In this way one can get perfect mobility and complete freedom from recurrent webbing.

CARCINOMA OF STOMACH

Dr. Kirby Dwight presented a man aged fifty-four, who was admitted to the Roosevelt Hospital in October, 1924, with an indirect inguinal hernia, a slight prolapse of the rectum and some stomach symptoms, for whom on March 19, 1925, he had done a Polya resection of the stomach on account of a large indurated ulcer on the posterior wall of the stomach. The anastomosis was made behind the colon and the efferent loop of jejunum was placed at the greater curvature. Microscopical examination of the ulcer showed adeno-carcinoma, and the nodes along the lesser and greater curvatures were involved. The patient made an uninterrupted recovery and was discharged on April 9.

He has been seen frequently since then and has been in splendid health with no gastric symptoms. X-ray examination shows complete emptying of the stomach in six hours. When last seen, in December, 1927, there was no evidence of metastasis or recurrence.

BILATERAL FRACTURE OF PELVIS WITH INTRA-PELVIC DISLOCATION OF THE HEAD OF THE FEMUR; FRACTURE OF HUMERUS

Dr. John J. Moorhead presented a woman, age thirty-five, who was admitted to Post Graduate Hospital, September 24, 1926. Three days prior to admission she fell from a second story through an open window. Immediately removed to hospital. On examination there she was found to have sustained:

1. Fracture of pelvis with intra-pelvic dislocation of the head of femur (left). Both sides of pelvis involved around obturator foramen.
2. Fracture of surgical neck of humerus (right) and acromion.
3. Contusions of face and about right eye.
4. Abdomen somewhat rigid in left lower quadrant. No urinary signs. Pulsation in leg and foot normal.

The treatment applied was: 1. Traction to arm and to thigh; both in abduction. 2. October 4. Transfixion of great trochanter by nail after unsuccessful effort by manual manipulation to reduce the fracture. While pulling on the spreader attached to the nail there was a decided sense of giving; further traction caused the nail to break almost in equal parts. The anterior half could not be removed. Plaster-of-Paris spica in traction and abduction. 3. October 7. Transfixion supracondylar. Traction up to forty pounds. October 13. Traction removed from arm. 4. October 28. Removal of supracondylar transfixion and the broken nail. Adhesive traction substituted. 5. November 8. Deformity recurred: Transfixion of great trochanter through original incision. 6. November 29. Plaster-of-Paris spica. 7. November 30. Out of bed on stretcher chair. 8. December 15. Spica removed. 9. December 21. Walked with crutches. Supracondylar wounds healed. Sinus in front and behind greater trochanter. Can bear weight with aid and hip motion is fairly free. Limb swollen. Arm motion very free. February 8. Still uses two crutches. Can elevate extremity eighteen inches off table. Knee bends to right angle: hip ditto. March 15. Uses cane. Decided

limp. May 13. Swelling less marked. Pulsation normal. Wounds closed September 26. One year after injury: Limp; swelling; some soreness region great trochanter. November 16. Half inch lift on shoe improves gait.

Present state. Limp moderate. Swelling slight. Shortening between one-half and three-fourth inch. Wound over trochanter recently broke down and discharged for a few days; now closed.

The knee is somewhat swollen and she complains of constant pain below the kneecap. There is moderate swelling with pitting below the knee. She can elevate the thigh twenty-one inches off the table; opposite thirty-four inches. There is abduction to 45 degrees. Adduction is normal. Rotation is much limited. Can bend the knee beyond right angle and squats readily. Deep pressure over the iliac region elicits some pain and an indefinite sensation of a mass. Pulsation is normal. She wears a shoe built up three-quarters of an inch.

KNEE-JOINT ARTHROTOMY FOR OSTEOCHONDRITIS DESSICANS

Dr. John J. Moorhead presented a girl, sixteen years of age, with the following history; in whose case an X-ray examination had shown a loose body on the under surface of the condyle of the femur close to the median line. By a mediolateral arthrotomy a dissecting osteochondritis the size of a small lima bean was easily shelled out from the site of the shadow in the radiogram. She remained in the hospital eight days. She now walks with a moderate limp and there is about 30 degrees flexion in the knee and extension therefrom is perfect. In a series of 102 consecutive arthrotomies this is the second case of osteochondritis dessicans.

FRACTURE OF NECK OF FEMUR IN PATIENT AGED 100 YEARS AND 9 MONTHS

Dr. John J. Moorhead said he first saw this patient in consultation with Dr. Scudder J. Woolley, March 27. On February 19 she had slipped from a low chair falling gently to the floor, sustaining a disabling injury of her left hip. On the date of her injury Doctor Imboden made a series of radiograms with a portable apparatus, finding a non-displaced fracture of the neck of the femur extending from just above the greater trochanter to the lesser trochanter and the latter was entirely detached. Treatment consisted of keeping the limb at rest by the aid of long sand bags. At the time of the examination in March, the extremity could be moved freely and painlessly and there was practically no evidence of injury. The patient is slightly irrational and had been difficult to control for about ten days. Her general physical condition was remarkable for a person of her years. She was born May 14, 1827, and thus at the time of her injury she was 100 years and 9 months old. She came from a long lived family, many of whom lived for over 90 years. In 1926, she had a severe attack of cholecystitis with jaundice and fever. The day after this examination she was allowed out of bed and remained up for nine hours. Two days ago Doctor Woolley reported that she was in excellent condition, was able to walk with slight assistance and that mentally she was quite normal.

In this connection Doctor Moorhead showed skiagraphs of another patient who is now 94 years of age and who two years ago had an intracapsular fracture of the neck of the femur. The X-ray series now shown indicates bony union. This patient was seen a few days ago and she is able to walk with the aid of a cane resting on the arm of an attendant.

SPLENECTOMY FOR GAUCHER'S DISEASE

DR. EDWIN BEER presented a man forty-nine years of age, who was admitted to the Medical Service of Mount Sinai Hospital, November 7, 1927. There the case was studied and subsequently transferred to the Surgical Service for splenectomy, with a diagnosis of Banti's disease of the thrombocytopenic type. The patient's history was briefly, that five weeks before admission he had pain in the right lower quadrant of the abdomen, which subsided in three weeks. He then developed weakness, and became anemic.

FIG. 1.—Extensive peripheral arteriosclerosis in a male forty-nine years of age suffering from Gaucher's disease. (Splenectomy.)

Splenectomy was performed November 22, 1927, a very large hard spleen, measuring 25 x 8 x 10 cm. and weighing 1600 gms., being removed. As Vierdot gives the average dimensions of the normal spleen at 12 x 3 x 7 cm. and the weight as approximately 171 gms., the tremendous increase in the size of the splenectomized organ is readily appreciated.

Excision was accomplished through a long subcostal incision, starting over the left rectus muscle, incising each sheath at the lateral border and running down parallel to the ribs about one and one-half inches from the arch, well over to the mid-axillary line. The pedicle was much spread out, and required multiple ligatures. There was no ascites, and the liver showed no cirrhosis, but was very large and smooth. The splenic artery showed marked arteriosclerosis, whereas the vein was soft. On cutting through the removed spleen, which was about nine times normal size, the surface looked like a section of the liver, and the macroscopic as well as the microscopic pathological report was Gaucher's disease.

Pre-operatively and post-operatively the family history was gone into, and no evidence of any other members of the family having this disease could be ascertained. The patient has a well brother, and five well children. The mother died at seventy-five years; cause unknown. The father is also dead, of unknown cause. The more or less characteristic pigmentation over the nose and face were never presented by this patient, and the pinguiculæ were never seen in his conjunctivæ.

The patient made a satisfactory convalescence, though owing to chromic gut knots he apparently developed some wound irritation and infection. It

was thought for a time that he had symptoms suggestive of a subphrenic abscess, but fortunately this never came to realization.

As far as laboratory reports are concerned, while in the hospital the urine was regularly negative. The direct Van den Bergh test was negative, and the indirect showed 1-200,000. The Wassermann was negative. The urobilin examination of the urine in 1900 c.c. over three days was 53 mgms.

One of the most interesting features of this case was the X-ray study of his extremities, partly carried out with the object of seeing whether any Gaucher manifestation might be found in the long bones. These X-rays showed the most extreme arterial thickening and calcification that one is likely to see. (Fig. 1.) For a male of forty-nine years such marked pipe stem vessels have never been seen by the reporter. The abdominal X-rays to determine the disease of the arteries never demonstrated these vessels, though at operation it was seen that the splenic artery was full of calcified placques and markedly arteriosclerotic.

The patient returned to the Follow-up Clinic April 21, 1928, apparently much improved in general health, having gained fifteen pounds, and feeling very well.

PYELOLITHOTOMY—DRAINAGE NEPHROTOMY—PERSISTENT CORTICAL CALICEAL FISTULA

Dr. Edwin Beer presented a woman to illustrate an unusual complication following pyelotomy and drainage nephrotomy, and at the same time to call attention to a procedure which has been recently suggested by one of Professor Alessandri's assistants in Rome.

The patient had three stones in the kidney, two apparently being in the cortex and one in the pelvis. The stone in the pelvis, despite the patient's size (she weighed about 220 pounds) was fairly easily removed by pyelotomy, but it was impossible to feel or locate two smaller stones which were apparently shut off in a calyx, and they therefore could not be removed through the pelvis. To recover these stones a small nephrotomy incision over the position of the stones was made, in the hope that through this drainage tract the stones might eventually be washed out.

The wound was slow in healing, and under the thick layer of fat a complicated suppurating sinus developed, which had to be split and left wide open. During all this time there was a small amount of urinary leakage, and on repeated cystoscopies (at which time the pelvis of the operated kidney was irrigated with indigo blue stained solution) none of this irrigating fluid appeared in the lumbar wound. Just as the wound was gradually closing but still leaking, a small stone about 1 cm. by ¼ cm. was fished out of the bottom of the sinus, and it was then hoped that the urinary leakage would cease. This leakage was never a great amount, but sufficient to keep the patient moist. It seemed to him that the nephrotomy incision had probably traversed a closed-off calyx which contained the two small stones, and that the presence of these small stones kept up the connection of the calyx with the lumbar wound.

Following the recovery of this last stone, two X-rays still showed a tiny stone, about the size of the head of a pin, which had been present at the original examination. Urinary leakage continued despite repeated irrigations of the pelvis of the operated kidney with antiseptics. The third stone never could be felt with a probe, and despite repeated curettings and attempts to fish out possible ligatures or foreign bodies with a crochet needle, and notwithstanding irrigation of the wound, as well as the pelvis, with a 1/2000 hydrochloric acid solution to dissolve the remaining phosphatic stone, the urinary leakage persisted, though the patient's general health was perfect and the kidney had improved in its function very materially.

This type of complication has been very rarely seen, and the persistent leakage had suggested the advisability of removing the whole organ, which might have been done if the second kidney had been a perfectly normal one. At times the patient would be dry, and then it was hoped the sinus was definitely closed. At the next visit, the leak had reappeared, and the sinus would admit a probe two or three inches. Heliotherapy was tried locally to stimulate, without any apparent results.

Having tried all the above measures locally in the wound, including iodinization, a strong solution of silver nitrate, hydrochloric acid, curetting, stretching, as well as irrigations of the kidney to control the infection and heliotherapy as a constitutional stimulant, we were pretty well at our wits' end when an article was published by Vittorio Ghiron, of Professor Alessandri's Clinic in Rome. This article appeared in the *Zentralblatt für Chirurgie* of May 14, 1927 (p. 1229), and the author suggested the use of a paste for the closing of persistent fistulæ, reporting its use in bladder fistulæ. This paste is made up of Kollagen 60 to 70 per cent. and iodin, thymol, and formol, each 3 to 6 per cent. The substance is melted over a water-bath and injected when fluidified. It rapidly hardens and fills the sinus. This substance, after having been used with success in two suprapubic fistulæ, was tried on this patient, the material having been obtained from Rome through the courtesy of Professor Alessandri. Following one injection this fistula (which had been present from the time of operation, thirteen and one-half months previous) immediately closed, and the patient has remained dry since the middle of January.

A letter received from Doctor Ghiron of Rome states that in some clinics it has been used also in vesico-vaginal and recto-vaginal fistulæ. For the benefit of those who may wish to use this new mixture, he added to the letter of November 19 sent to him from Rome, which describes the technic used, as follows:

"For the use of the Kollagen, you must melt it in water-bath or upon a lamp and then pour it out on a little warmed board. Mingle it with the powder and let it fall on the fistula little by little in way of covering it completely. Pay attention to put a considerable quantity of Kollagen on the skin all around the fistula because a greater surface of adherence may be formed by this system. Remember that the Kollagen solidifying becomes quite a third of the former volume. In the suprapubic fistulæ I often mingle the Kollagen and the powder in the fistula, mixing the two substances with a little spatula. In the narrow and very deep fistulæ you could inject it with a syringe (possibly metallic), taking care to warm it first. In this case the quantity of powder to be added must be very little else it would solidify all at once in the syringe and the injection could not be possible.

"Having put in the Kollagen I cover it with dry gauze leaving a Nelaton catheter for several days, and I keep the patient resting. When the Kollagen begins to detach I use damp hot applications to help the complete detachment and the cicatrization. When the fistula is large I must use the Kollagen a second time. In Germany where I was asked to send the Kollagen it was used also for vesico-vaginal and recto-vaginal fistulæ. In this case the quantity of powder must be greater in order to solidify rapidly the Kollagen. One could also use one or two stitches to dry quicker the margins and then cover with the Kollagen."

OSTEOMYELITIS

Doctors Fenwick Beekman and Carl Burdick presented a group of cases in illustration of the paper of the evening.

CONSERVATIVE OPERATIONS IN CHRONIC OSTEOMYELITIS

DR. WALTER M. BRICKNER said that in the treatment of chronic osteomyelitis, as evidenced, for example, by the presence of a bone sinus, the practice has been very general of proceeding at once to a radical osteotomy —chiseling away bone about the sinus and then removing still more until there is created a boat-shaped cavity ("saucerization") made contiguous with the wound margins by packing it with gauze. This plan of attack is based upon the presumptions that by free osteotomy one can remove the disease, leaving only a healthy column of solid bone, and that by providing a properly shaped trough, definitive healing of the wound from the bottom will be gradually effected. This primary radical osteotomy and saucerization, without waiting for involucrum or sequestrum, is an essential part of the Orr method, which also involves extensive and prolonged immobilization of the entire extremity in plaster-of-Paris applied directly over the dressing.

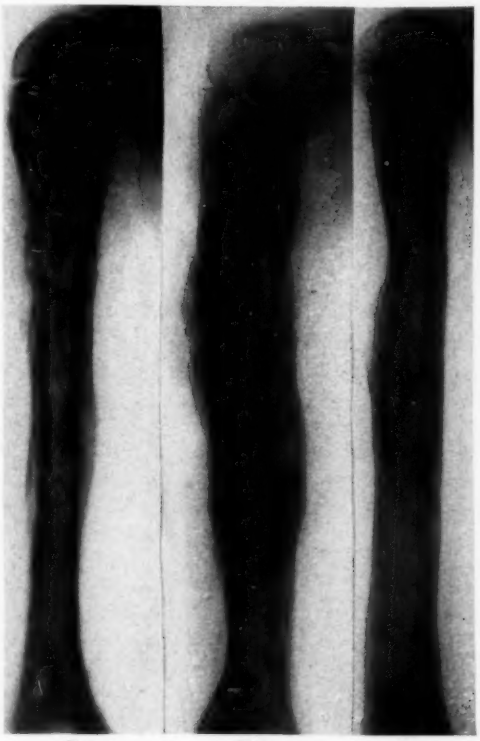


FIG. 1. FIG. 2. FIG. 3.

FIG. 1.—Case 1.—May 26, 1926. Extensive necrosis involving two-thirds of the shaft of the humerus with only slight involucrum formation.

FIG. 2.—Case 1.—Six months later, November 13, 1926. A very solid supporting involucrum has formed and there are now three sequestra lying in three discrete cavities.

FIG. 3.—Case 1.—One year after Fig. 2 (November 19, 1927). The humerus now shows a fairly normal shaft of healthy bone with no cavity and no area of necrosis. No operation for the chronic osteomyelitis was performed in this case except the simple removal of the three sequestra shown in Fig. 2.

DOCTOR BRICKNER said that he had become convinced that *primary* radical osteotomy and saucerization, which he had been taught to follow, is often unnecessary and usually involves prolonged hospitalization and invalidism. He called attention to a paper read by him before the American Medical Association in 1925, and published in the *J. A. M. A.*, vol. lxxxv, p. 1782, December 5, 1925.

DOCTOR BRICKNER then demonstrated the following cases:

A girl now about twelve years old, who, in June, 1926, was admitted to the Hospital for Joint Diseases. She had been operated on some months before for acute osteomyelitis of the right humerus and had three moderately discharging sinuses leading to the upper half of the shaft of the bone. Röntgenograms showed two-thirds the length of the diaphysis extensively porous, necrotic, with two incompletely formed sequestra, and with only beginning involucrum formation. (Fig. 1.) If a radical operation had

FIG. 4.—Case 2.—August 17, 1927. One month after simple removal of sequestrum from the cavity in the upper third of the tibia.

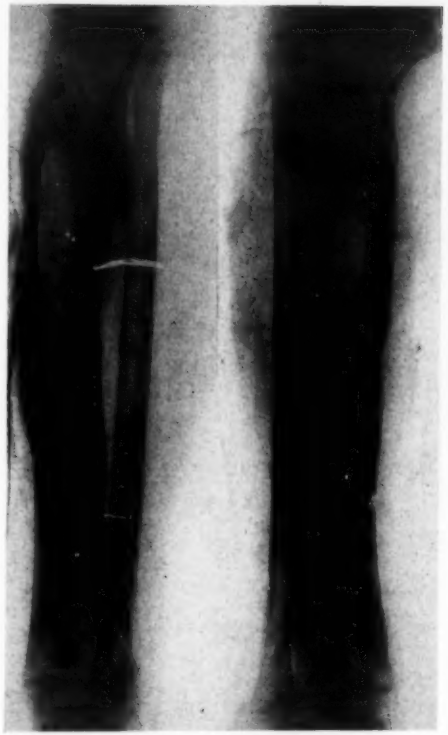


FIG. 5.—Case 2.—September 2, 1927. About seven weeks after simple sequestrectomy. Note that the cavity is smaller.

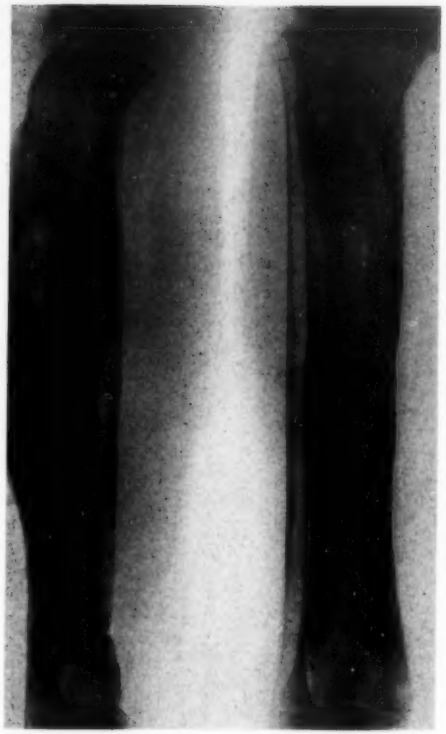


FIG. 6.—Case 2.—October 17, 1927. Six and one-half weeks after Fig. 5. The bone cavity is much smaller.

then been performed, removing all the diseased bone, fully half the length of the humerus would have been resected, and in the almost complete absence of involucrum to bridge this defect, the arm would have collapsed. The child was discharged from the hospital under observation, and readmitted five months later (November, 1926), at which time röntgenograms showed that there was a well-formed supporting involucrum and that the process of necrosis had resolved into three slender sequestra each about two inches long, lying in three separate cavities communicating with the three sinuses. (Fig. 2.) An incision was made through each of these, the cloacæ in the bone were enlarged only sufficiently to remove the sequestra by morcellation, and a small gauze wick was inserted into each cavity for drainage. These were removed in a few days. The wounds closed over rapidly and completely and have remained soundly healed ever since (now a year and a half.) Röntgenograms today show the humerus as a solid shaft of healthy bone, *with no cavities.* (Fig. 3.)

The child has also had osteomyelitis of the right clavicle, the left humerus and the left tibia, all treated by similar quite conservative measures, and all at this time healed.

A little boy was admitted to the Hospital for Joint Diseases July, 1927, with an osteomyelitis of the tibia of two months' standing. A suppurating sinus in the skin led into a large cavity in the shaft, containing a good-sized sequestrum, and discharging through a comparatively small opening in the bone. The latter was enlarged sufficiently to extract the sequestrum. The cavity was drained with gauze only until the discharge was serous. Then the drain was discarded and the skin was allowed to heal over the cavity. It has remained solidly healed and röntgenograms have showed progressive diminution and final disappearance of the cavity. (Figs. 4–7.)

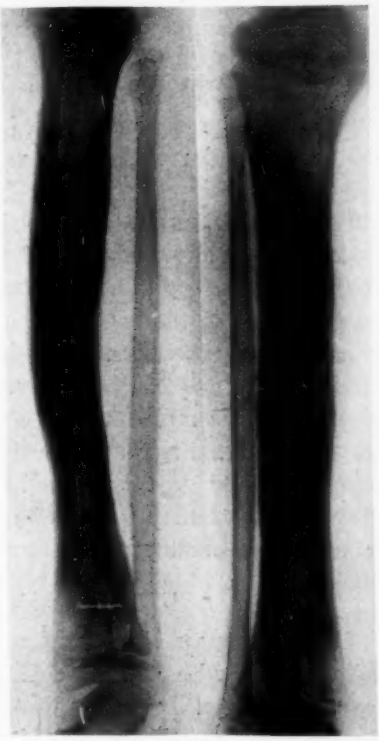


FIG. 7.—Case 2.—April 20, 1928. Six months after Fig. 6. The cavity as such has disappeared. No operation was done for the chronic osteomyelitis in this case except the removal of the sequestrum from the bone cavity over which the skin soon healed and has remained well healed. Note that the röntgenogram shows a small focus of bone absorption in the lower third of the tibia. Here a small abscess formed in January, 1928, and closed after simple incision.

A little girl was admitted to the orthopædic service of the Hospital for Joint Diseases July, 1927, with what was believed to be a pyarthrosis of the right hip, and high fever. Exploration of the hip by one of the staff was negative. A septic condition continued and suppuration in the soft parts was drained by an incision in the lower thigh and one above the hip. In spite of these the high fever persisted when, on August 31, the child was transferred to Doctor Brickner's service. At that time a röntgenogram showed only what appeared to be a pathological fracture through the neck of the femur, without displacement. Two weeks later, however, a röntgenogram showed also rarefaction and beginning necrosis of the trochanteric region and ten days later röntgenography showed this area extensively

broken down. It is evident that treatment by osteotomy of this diseased area would have meant resection with consequent great shortening of the extremity. The high fever continuing, Doctor Brickner made an incision over the trochanter, evacuating a little pus from beneath the aponeurosis, and removed a small piece of the diseased bone for examination. This showed a non-specific osteomyelitis—nothing suggestive of neoplasm, tuberculosis, or syphilis. (The Wassermann reaction was negative.) A fenestrated plaster-of-Paris spica was applied. All three wounds very soon healed and the fever disappeared. A röntgenogram in December, 1927, showed bony regeneration of the diseased area. The case was removed in February, 1928. The child is entirely well.

These three cases are all of small children, but the speaker has secured the same results with such conservative measures in adults with chronic osteomyelitis.

The operations in these, as in most such cases, are comparatively minor and often involve little or no confinement to bed. They are contrary to the widely accepted belief that sound healing cannot take place over a "dead space" in the bone, that overhanging bone must be removed, and that healing must take place from the bottom. That belief was also opposed as an argument when Doctor Brickner began his treatment of chronic bone abscesses by simple evacuation through a small drill hole. Yet he has shown again and again that such chronic abscesses are usually sterile, or contain attenuated organisms, and that simple drill drainage not only promptly relieves pain but, also, is followed by definitive healing even though the bone cavity, small or large, cortical or medullary, may remain indefinitely.

ACUTE HÆMATOGENOUS OSTEOMYELITIS

Dr. Fenwick Beekman read a paper with the above title, written in collaboration with Dr. Carl G. Burdick, for which see page 270, Annals of Surgery, vol. lxxxviii.

Dr. Carl G. Burdick said that it is surprising how many surgeons fail to realize that in the early stage of an acute osteomyelitis the X-ray is negative, and that operation must be performed before any bony changes are revealed to accomplish the ideals we are striving for. The radical methods of several years ago in which a large part of the cortex was removed have been discarded, and the simpler methods of drainage are now giving satisfactory results without the destruction of a large amount of normal bone and periosteum.

In the chronic cases the problem has not been solved as satisfactorily. Sub-periosteal resection of a large part of the shaft of the bone involved, he believed was no longer considered a wise procedure. At Bellevue they have been very conservative and have only removed the sequestra after they are entirely separated, through small incisions, but this has resulted in the children being hospitalized for many months.

Dr. Frederic W. Bancroft said that Doctor Beekman has stressed an important point on the necessity for the preservation of the blood supply

in operation, and to create surgical drainage with as little trauma as possible. The process appears to him as an embolus occurring in the terminal branches of the nutrient artery: The primary suppuration occurs about this embolus, so that the pus extends rapidly to lie beneath the periosteum. At the same time there is a retrograde thrombosis of the vessels, producing the death of bone. The points that seem to establish this pathology are: 1. That the pain always starts in the neighborhood of the metaphysis. 2. That if cases are operated on early, the percentage of cases developing late necrosis is markedly reduced. 3. Those cases that are operated upon late almost always have sequestrum formation. 4. The sequestration usually follows definite anatomic lines, either from one metaphysis to the distribution of that branch of the nutrient artery, or from one metaphysis to the other—that is, the distribution of the entire nutrient artery.

Dr. Seward Erdman said that surgery for this condition has certainly undergone marked improvement in recent years. Another aspect is the patient's side of the question; what is to guard him against subsequent attacks of osteomyelitis? Has Doctor Beekman any statistics as to the percentage of cases that have recurrence. Not rarely these patients have osteomyelitis in childhood, a remission of two or three years and then recurrence in some other bone, and so on through life. What is the cause of this and wherein is the defect? It is easy to say they have lowered resistance to staphylococcus infection. The theory of latent infection in the affected bone is illustrated by a case reported by Dr. Walton Martin. A boy had osteomyelitis of the tibia and two years later had osteomyelitis of the radius. During his first stay in the hospital he had complained of pain in the wrist. A picture of the wrist was taken which seemed to show a slight change in the radius. There was temporary redness and swelling but these subsided and the patient went home. A year or two later the radius flared up and had to be opened and drained. The theory was that at the time of the original infection of the tibia some emboli had lodged in the radius and remained quiescent for years.

Another theory is that reinfection occurs from some active but perhaps hidden focus elsewhere in the body. The work of Dr. Robert A. Cooke, in showing with what frequency a chronic antrum infection is due to staphylococcus and may play an important part in the etiology of disease of the respiratory tract, was applied by the speaker with quite convincing results to two obstinately recurring cases of osteomyelitis. One of these cases was treated conjointly with Doctor Cooke and in both cases a chronic antral infection, unsuspected by the patient, was shown by X-ray and by culture from the sinus. The clearing up of the antrum infection has to date given freedom from recurrence of bone abscess. Doctor Erdman believes that heretofore not enough attention has been given to this phase in the etiology of recurrent osteomyelitis.

Dr. Alexis V. Moschcowitz said that there is a patient who first entered Mount Sinai Hospital, thirty years ago with osteomyelitis, went home apparently cured, but ever since at intervals of a few years comes back with a

history of having been treated at other hospitals. He has had thirty or forty major operations and has forgotten the number of minor operations. The speaker had often heard Doctor Brewer say: "Once a case of osteomyelitis, always a case of osteomyelitis." It is impossible to foretell if any patient will always remain well when once apparently cured.

Dr. Charles E. Farr said that many surgeons did extensive operations as a result of having their curiosity aroused by röntgenograms. Personally he always left these patients alone as far as possible. But the X-rays had proved useful to him by revealing lesions that might otherwise have been overlooked and that were possible foci for trouble later on. In this way a considerable number of Brodie's abscesses have been discovered by routine X-rays.

In children the healing and absorbing powers are very great. Lesions of considerable extent will disappear under rest, sunlight and good food. Once the tension has been relieved by suitable incisions in the soft parts, supplemented with bone removal if deemed necessary, nothing is lost by giving plenty of time for nature to exert her powers.

Dr. John J. Moorhead stated that as he understood it the Orr treatment was a combination of débridement, vaseline gauze packs and immobilization. This was practically the same as the so-called Bipp treatment which had a short vogue in France during the war where it was sponsored by the British. In so far as technic is concerned it is the exact opposite of the Carrel-Dakin method which is meticulous in care and subsequent management. This let alone and immobilization treatment is certainly anything but surgical, as he understood it, the dressings are not changed until they become foul enough to make an actual stench.

The speaker was in accord with Doctor Moschcowitz's quotation which being paraphrased is "Once an osteomyelitis, always an osteomyelitis". The longest quiescent period with which the speaker was familiar was in the case of a patient who came into his Clinic at the Post Graduate with a spontaneous fracture of the upper end of the humerus at the site of an osteomyelitis which had remained dormant thirty-nine years. Doctor Moorhead expressed his doubt of the permanence of cure by any of the methods of the present day treatment, and felt that if cases were followed long enough they would continue to show recurrence.

Dr. Edwin Beer mentioned a patient in whom he had done a total removal of the fibula for osteomyelitis with bacteriæmia, but the bacteriæmia continued and other foci developed and the patient died. The most deplorable of all these cases were those Doctor Erdman had referred to with multiple lesions and at the present time the problem they present is most discouraging. In one such case he had tried weekly intravenous gentian violet and while the treatment was going on a new focus developed.

Doctor Beekman, in closing, agreed with Doctor Brickner that in the treatment of chronic cases one can often remove the sequestrum through the sinus, and that the cavity will promptly close. He had noted that in

doing this some marrow was often removed with the sequestrum, demonstrating that new marrow is frequently formed around the sequestrum.

The speaker could not conceive the thromboembolic theory of bone destruction in acute osteomyelitis. He had noted that in the cases with early suppurative arthritis that the lesion in the bone did not spread if the joint had become infected. He believed that any outlet for the pus, whether into the joint or into the soft parts, will often prevent further spread within the bone. The speaker did not believe it possible to infect a bone through a drill hole. As to the recurrences of new lesions, these did not amount to more than 15 per cent., though if an individual developed a secondary lesion others were very apt to follow.

As to the source of the blood infection producing the secondary lesions, the speaker stated that they could come from a bacteriæmia resulting either from the primary lesion or one of the secondary lesions. Doctor Beekman believed that in the cases of staphylococcus aureus that the re-infection usually came from the bone lesion. In those cases of streptococci infections, he believed a primary lesion in the tonsils or pharynx was accountable. As to the question whether the removal of a bone in the early stages of an osteomyelitis will cure the disease, the question was purely theoretical. In Doctor Beer's case the cure did not occur.

In the beginning of an osteomyelitis if there is continuous bacteriæmia, one does not know whether it is produced by the focus at the point of entrance or the bone lesion. If it is produced by the latter lesion resection of the bone will possibly remove it. The speaker stated that he had tried to lay stress in his paper upon the fact that in treating these cases one is caring not only for the osteomyelitis but often for an active blood infection, the former being but a complication of the latter. In this type of case death frequently takes place within the first three days of the disease, but it is the result of the sepsis, not of the osteomyelitis.

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD NOVEMBER 5, 1928

The President, Dr. Astley P. C. Ashhurst, in the Chair

Dr. Calvin M. Smyth, Jr., Recorder

OSTEITIS FIBROSA CYSTICA

Dr. Hubley R. Owen and Dr. Searle Lanyon reported the case of a colored man of uncertain age, who was admitted to the Philadelphia General Hospital, February 5, 1928, with an injury to the left leg which he had acquired forty-eight hours before admission. He gave a history of having had a fracture of the right ankle twenty years ago, at which time he was incapacitated for three weeks. He did not have a physician in attendance at that time, but states, "two old colored men fixed" his leg for him and he had no subsequent trouble. He had gonorrhœa fifteen years ago and also had a chancre the same year. About four years ago he complained of pain in the lower end of his spine, which came on suddenly and which was not caused by trauma. He complained of pain on stooping or on walking. He had X-ray studies of his spine in the Germantown Hospital. He remained in this hospital for two weeks. He was then discharged and has had no further trouble with his back.

Examination revealed external rotation of the right foot; pain on motion of the right hip and three quarters of an inch shortening. The blood Wassermann was negative.

X-ray examination resulted in the report of an intertrochanteric fracture of the left femur. The bones of the sacrum, entire pelvis, both femora and proximal fourth of the right fibula, all the lumbar and dorsal vertebræ, both scapular, both humeri, the distal ends of clavicles, proximal fourth of the radius and ulna, the ribs, mandible, cervical vertebræ, and the bones of skull and face showed a peculiar rarefied condition. Numerous trabeculæ were demonstrable particularly, in the lower vertebræ, pelvis, femora and the heads of the humeri. There was a synostosis between the tibia and fibula at the distal fourth of the right tibia. The latter may have been fractured. Whether this is osteomalacia or an osteitis fibrosa cystica is indefinite. Singularly, the distribution of the involvement is analagous to that seen in carcinoma.

Biopsy on a specimen removed from the left femur below the point of fracture showed the following: "Cortex is thin. The surface appears rough. A ragged looking medulla containing several fatty areas. The bone tissue is hard. Microscopically the section shows the cortex of the bone markedly thin. The external surface shows irregular areas of absorption. The inner side as well as the medullary and cancellous portions show areas of absorption and replacement of loose œdematous fibrous tissue. No giant cells are found in these tissues. Primary and metastatic growth can be ruled out. Histologic picture is suggestive, but not absolutely typical of osteitis fibrosa cystica." (Dr. W. B. Belk and Dr. T. J. Jodzie.)

The speaker called attention to the diversity of opinion as to the pathological status of this condition and quoted at some length from numerous

authorities. The most recent opinion expressed in the Robert Jones Birthday Volume in June, 1928, classifies fibrocystic disease of bones into five groups as follows:

1. Cases with multiple cysts, fibrosis and malacia confined to a few bones, occurring in young people.

FIG. 1.—X-ray showing appearance of bone in case of Osteitis Fibrosa Cystica. The same appearance was noted in pictures of all the long bones of the body.

2. Multiple cysts with fibrosis and predominant general malacia, occurring nearly always in women.

3. Multiple cysts with fibrosis, general malacia and hyperostosis.

4. Cases with cysts, fibrosis and giant cell tumors, but no marked malacia.

5. Cases with cysts, fibrosis and giant cell tumors, with malacia and with or without hyperostosis.

These patients become severely deformed, bedridden and eventually die

EPSTEIN'S NEPHROSIS (LIPOID NEPHROSIS) SIMULATING TUBERCULOUS PERITONITIS

Dr. Hubley R. Owen and Dr. Helen Ingleby reported the case of a colored boy, aged sixteen years, who was admitted to the Tuberculosis Department of the Philadelphia General Hospital, February 16, 1928, with the chief complaint of swelling of the abdomen. There was nothing in his family history suggestive of tuberculosis or malignancy. He gave the history of having been treated in the Ruth Hospital for Consumptives in 1926 and later sent to a sanatorium for the treatment of tuberculosis. His present illness dates from January 20, 1928, when he became suddenly ill with nausea, vomiting, lassitude and constipation. He complained of a dull pain in the lower part of the abdomen; developed dyspnœa on slight exertion, polyuria and nocturia and swelling of the abdomen. No hæmaturia.

Physical examination showed puffiness of the face; the abdomen distended with fluid and œdema of the ankles. The heart and lungs were clear. Blood pressure 100/50. The temperature was irregular, rising to 102° before death. The pulse ranged from 80 to 150. The respirations which were 24 on admission increased gradually to 60. The urine was dark amber in color. Albumen varied from a trace to a very heavy cloud; leucocytes, epithelial cells and hyaline casts were also found.

Blood analysis.—The blood was old rose in color with colloidal milky appearance. Chemical analysis showed urea 75, uric acid 4.2, cholesterol 700, creatinin 5.6, chlorides 562, sugar 0.107, carbon dioxide 25 per cent. *Cytology.*—Red blood cells 2,080,000, hæmoglobin 11.8 per cent, white blood cells, 97,000, polynuclears 84 per cent, lymphocytes 16 per cent.

The first diagnosis made was that of tuberculous peritonitis and the patient was transferred to the surgical service. Abdominal paracentesis was performed and 4000 cubic centimetres of milky fluid was withdrawn. The patient grew weaker and complained of abdominal pain. He died March 9, 1928.

At autopsy both pleural cavities were found to contain about 200 cubic centimetres of pink milky fluid, apparently a blood-stained transudate. The pericardial sac contained about ten cubic centimetres of yellow opalescent fluid. The abdomen was distended and the peritoneal cavity contained about one-half litre of milky fluid. In the pelvis and behind the ascending colon the fluid contained thick flakes of fibrin. Part of the surface was smooth and glistening. Fibrinous flakes were adherent to the ascending colon and sigmoid. The kidneys were considerably larger than usual. The left measured 15.5 x 8.5 x 5 centimetres and weighed 400 grams. The right was slightly smaller. The capsule was thin and stripped easily. The surface was smooth except for the remains of fœtal lobulation. It was mottled red and gray, or grayish-yellow and stippled with gray and yellow points. The substance was soft and œdematous and had a somewhat greasy feel. The cut surface was likewise mottled. The cortex was extremely wide—1.5–2 centimetre—and stippled with gray and yellow. These gray and yellow dots represented dilated tubules. The glomeruli were just visible. The medulla was darker than the cortex, but the distinction between the two was blurred, more so than is usual in this condition. The pelvic fat was not abnormally increased. The vessels were not prominent.

Examination revealed enormous dilatation of the tubules. The dilatation affected chiefly the convoluted tubules. These dilated tubules were lined by flattened cells. Sometimes these cells bore a faint likeness to the normal, but mostly they were flattened beyond recognition. The lumen contained a pink staining substance, sometimes homogeneous, sometimes granular. This substance stained faintly yellow-red with sudan and very faintly with scharlach r. The loops of Henle were a little dilated and contained

the same kind of substance. The collecting tubules were somewhat dilated; some contained homogeneous material. The glomeruli were scattered owing to the increase in the size of the tubules. They showed multiplication of the nuclei, swelling and granular degeneration of the protoplasm. Sometimes they nearly filled the glomerular space, but more often the space was distended with a homogeneous material resembling that found in the tubules. The interstitial tissue was increased, especially in the medulla; with fat stains this was seen to be due in great part to a deposit of lipoids. Much of the fat was contained in wandering cells. With scharlach r, it stained bright red, with sudan III, yellow-red, and with nile blue, pink. This is characteristic of cholesterin esters. Apart from the fat-containing cells, round-cells resembling lymphocytes were fairly numerous. Fat-containing cells were found here and there in the lumen of the tubules. The vessels were inconspicuous. When examined carefully, fat-containing cells were found within them, also minute droplets of fat lying in the interstitial spaces between the red cells.

The heart muscle was pale and the left ventricle showed no hypertrophy; microscopically the cells contained fine droplets of fat. The liver showed fatty infiltration and the Kupffer cells contained cholesterin esters. The lungs showed patches of bronchopneumonia, and one of the glands at the hilum of the right lung contained pus. There was no evidence of tuberculosis in any of the organs. Bacteriological examination of the heart's blood, lung, and pelvis showed *B. coli communis.*

Except for the terminal rise of non-protein nitrogen in the blood, this case was a typical one of Epstein's nephrosis. In the kidney, however, the lipoid, instead of being chiefly in the tubules, was found in the interstitial tissue. The reason for this was probably that the lipoid-containing cells of the tubules had all been shed and had disintegrated. Some of the lipoid had been passed in the urine, some carried into the interstitial tissue by wandering cells. The flattened cells which replaced the normal epithelium were apparently not capable of being filled with lipoid. One would argue from this that death occurred at a late stage of the disease. It is possible that his sojourn at a sanatorium in 1926 in reality marked the beginning of his nephrosis.

Dr. Hubley R. Owen remarked that the condition known as Epstein's nephrosis is closely related to chronic parenchymatous degeneration of the kidney and other organs; the condition is more a medical than a surgical one—the only surgical aspect being the peritonitis which simulates tuberculous peritonitis. The interesting thing about this patient was that he had been in the ward for treatment for tuberculosis and had been in two other hospitals for treatment for this condition; yet the post-morten showed no tuberculous process.

Dr. Helen Ingleby said that Epstein believes that the condition is a metabolic disturbance and is due to an abnormal fluid in the kidney, which is excreted just as sugar is excreted in diabetes. Jelwin, however, believes that it is primarily a kidney defect and that the rest of the disturbance follows it. It is sometimes associated with myxœdema, in some cases it may be bad, in others it may be on the border-line, and in still other cases it is much benefited by the administration of thyroid extract. An interesting point is that in the clear-cut cases there should be no nitrogen retention; in this case, there was. However, some time toward the end of the disease it may

happen. In pure uncomplicated cases apparently the kidney can excrete anything quite easily, and the only reason it may not be excreted is that the fluid goes into the tissues and never reaches the kidneys; if it reaches the kidneys it will be excreted. In the typical case fat should be found in the tubules, but this case was so advanced that the tubules were not capable of holding any more fat. The finding of ascites chylosus in Epstein's nephrosis is a common occurrence. In this case there was no obstruction of the thoracic duct at autopsy.

SPINDLE-CELL SARCOMA OF THE FOOT

DR. WALTER G. ELMER presented a man, twenty-four years of age, who was admitted to the Orthopædic Dispensary of the Graduate Hospital of the University of Pennsylvania, August 4, 1925, complaining of pain in the left foot. He walked with a slight limp. For two months he had noticed a small, firm mass below and in front of the external malleolus which was slowly increasing in size, was tender and caused pain. The ankle-joint motion was normal and the tarsal mobility normal. He was admitted to the hospital and the mass was dissected out without cutting into its capsule. It was imbedded in the soft tissues outside the joint capsule and overlying the joint between the astragalus and os calcis. The pathologist's report on this tumor was spindle-cell sarcoma. The patient was then referred to the X-ray department for treatment. X-ray examination showed no disease of the bone. Later examination, taken in December, 1925, showed such marked absorption taking place in the astragalus and os calcis that the reporter was unable to determine whether this was due to the X-ray treatment or to a return of the growth. The scar tissue seemed to be healthy. An exploratory operation was made. X-ray of the lungs showed no metastases. The scar tissue was dissected out and bone shavings reamed out of the decalcified area. Frozen sections showed no evidence of tumor tissue. The wound was therefore packed with gauze and allowed to heal. The patient has remained in good health, has no symptoms whatever and walks with a natural gait, and tarsal mobility is normal. X-ray examination made May 26, 1927, shows the astragalus and os calcis completely returned to normal.

By way of contrast DOCTOR ELMER presented a man, aged twenty-two years, who was brought to the speaker, October 3, 1928, with the history that in January, 1928, he struck his knee when he fell down several steps, but did not realize he had done himself any injury until a month later, when his knee became swollen and painful. When first seen the region of the right knee was much enlarged—the mass was firm and dense with two discharging sinuses. The knee was flexed about twenty degrees and there was very little joint motion. The patient was thin, pale, and looked very ill. There were firm nodular masses in the right groin. He was admitted to the Graduate Hospital. X-ray showed a tumor mass surrounding the lower end of the femur, the bone had the appearance of an osteomyelitis of the epiphysis and lower portion of the shaft. On the anterior surface of the shaft there was an elevated strip of periosteum. The cartilages of the knee-joint seemed to be normal and the joint itself had not been invaded. Cultures from the sinuses showed staphylococcus aureus and hæmolytic streptococcus. The diagnosis of osteogenetic sarcoma with metastasis to the groin was made. X-ray of the chest showed extensive involvement of both lungs. There was nothing to be done except advise the patient to return to his home.

DR. WILLIAM J. RYAN said that he had had under his care a woman, aged sixty-two years, who, in September, 1926, had struck her knee which

was followed by the development of a small lump. This was removed and she came under the speaker's care in May, 1927, at which time she had a recurrence of the lump. The mass was situated just below the tibial attachment of the patellar ligament and a biopsy was done—the laboratory report being spindle-cell sarcoma. The mass stripped off the periosteum of the tibia very easily. There did not appear to be any involvement of the bone. Local recurrence occurred within one month's time and the patient refused amputation. It was therefore treated by electrocoagulation and X-ray and removed, but recurred again in two months' time. She refused to have anything done until the mass grew to an enormous size, and because of this, and also because of the odor, she consented to an amputation which was done in July of this year (1928). Repeated X-ray examinations of all the other bones were negative. X-ray of the chest was negative. There seemed to the speaker to be several unusual things in connection with this case—first, the age of the patient, *i.e.*, sixty-two years, and second, the recurrence at the local site with no evidence of metastases anywhere. The patient is now in good general condition.

Dr. George M. Dorrance said that in his experience with cases of sarcoma of the limbs there is an apparent disposition to metastasis in the opposite extremity. He feels that it is more liable to be to the limbs than to the lungs. In these cases even amputation does not offer a great deal and the speaker thinks the results are better from treatment with the X-ray without operation than with operation.

Dr. John H. Jopson said that fibrosarcomata of the foot have a tendency to recur and that this has always been recognized in the literature. The speaker operated, a number of years ago, when a patient who had been operated upon two or three times, over a period of years, before the final amputation to which he later succumbed. It was Doctor Jopson's recollection that in the literature the consensus of opinion was that cases of this kind and in this region did recur. Spindle-cell sarcoma—not osteogenic sarcoma—arising in the fibrous portion of the periosteum or the fibrous tissue show a prompt tendency to local recurrence in the foot.

EMPYEMA AND SUPPURATIVE PERICARDITIS: THORACOTOMY AND PERICARDIOTOMY

Dr. Damon B. Pfeiffer reported the history of a boy, aged fourteen years, previously healthy, who was admitted to the Presbyterian Hospital May 28, 1928. Three weeks before admission he developed a cough and pain in the right chest. That night he had a chill, followed by nausea and vomiting, and thereafter ran a typical course of severe right-sided lobar pneumonia. In ten days he improved apparently by crisis, but his cough continued and breathing became more difficult. The cough though persistent was unproductive. On the day of admission his temperature ranged between 99° and 101.6°, his pulse between 124 and 148 and his respirations between 40 and 54 per minute. He was extremely pale and obviously very sick. He presented the signs of a massive collection of fluid in the right pleura. The heart seemed to be pushed well over to the left. The sounds were of fair quality and no adventitious sounds were detected. The urine showed a trace of albumin and many granular casts. The leucocytes numbered 11,000 per cubic millimetre with 75 per cent. polymorphonuclears. The X-ray verified the presence of fluid, filling the chest to the line of the second rib. On the

day following admission his condition seemed so grave that it was decided to remove a quantity of the pus by aspiration before attempting a thoracotomy, and 122 cubic centimetres of thick greenish-yellow pus was withdrawn from which a pure culture of pneumococcus was isolated. This was followed by a fall in temperature, pulse and respiration with evident clinical improvement. Two days later, under local anæsthesia, a resection of the ninth rib was made in the mid-axillary line. Following this, although drainage was satisfactory, he failed to improve as might have been expected. The temperature gradually rose, reaching 104° in the evening, three days after operation, and the pulse hovered around 130. The respirations, however, diminished in number, averaging about thirty per minute. Dakinization of the pleural cavity failed to reduce the toxæmia. Physical examination at this time showed an unusually large area of cardiac dulness and the possibility of pericarditis was considered. June 7, the report of an X-ray examination by Doctor Newcomet stated "from the character of the heart shadow it would appear as if there was some fluid in the pericardium. The transverse diameter of the heart at the base is sixteen centimetres while at the base of the auricle it is thirteen centimetres. Right and left diaphragm can be seen, though both are hazy."

The following day pericardiotomy was performed under local anæsthesia. There was no difficulty and the patient did not experience the slightest discomfort. A double curved incision was made, as described by Doctor Pool, beginning over the sternum at the base of the fourth costal cartilage. The skin and superficial fascia were dissected back on each side, exposing the costal cartilages, and from one to one and a half inches of the fifth, sixth and seventh cartilages were resected. The intercostal muscles and posterior perichondrium were then incised, exposing the internal mammary artery which was tied at the upper and lower angles of the incision. The triangularis sternii muscle and the fatty areolar tissues were displaced outward, exposing the pericardium. The pleura was not defined, being covered by and displaced with the above tissues. It is worthy of note here that before incising the intercostal muscles the heart could be felt beating forcibly immediately beneath this layer, and when an exploratory needle was introduced to reinforce the conviction that the pericardium contained fluid, none was obtained. When the pericardium itself was exposed, however, and it was possible to insert the needle obliquely between the membrane and the apex, which was pounding against it, fluid was at once obtained, which was turbid and slightly flaky. Culture subsequently showed the pneumococcus. This illustrates the difficulty which may be experienced in obtaining fluid by simple paracentesis in early cases, before the effusion has attained a large size. The pericardium was then incised and found to contain about 150 cubic centimetres of thin purulent fluid. The serous surfaces were slightly dull, but there was no adherent fibrin. The incision was extended longitudinally for about two inches, its lowermost point being at the extreme diaphragmatic attachment. Two soft rubber tubular (Penrose) drains were then placed in the bottom of the sac and fixed to the pericardial edge. A single stitch was taken through the skin above and below, the pericardium being completely exposed, and dressed with a light gauze pack placed over the wound.

The beneficial effect of this procedure was at once apparent. The signs and symptoms immediately improved. On the second day the wound was dressed with the intention of beginning Dakinization of the sac, but the wound was found to be filled with yellowish, rubbery fibrin, evidently coagulated exudate. The drains were embedded in this mass and it was clear that they were completely isolated from the pericardial sac in the same manner and by

the same mechanism as abdominal drains after the first few hours. Irrigation with Dakin's solution was, nevertheless, begun hoping to sterilize the sinus and dissolve the exudate. The fibrin, however, failed to dissolve and the temperature after falling for five days again rose and remained between 101° and 103°. This condition was maintained practically without change for several weeks.

June 22, X-ray showed the right lung expanded with no change in either size or shape of the heart. June 27, a blood transfusion was given but with no observable improvement. The persistence of the fever in the absence of blood-stream infection made the reporter fear that the fibrinous exudate in the pericardium was breaking down and forming encapsulated collections, which it would be difficult or impossible to drain. However, about this time, the temperature began to fall gradually and except for an exacerbation due to the formation of a small pocket at the base of the right pleura, which was detected by lipoidal and drained by inserting a longer tube, the patient recovered without further incident. The tube was removed from the pericardial sinus and the patient discharged August 11, 1928, after an illness lasting thirteen weeks from the onset and about eight weeks from the pericardiotomy.

November 5, approximately three months after leaving the hospital, an electrocardiogram by Dr. James Talley showed a flattening of all the "T's" in all of the leads which, in the absence of cardiac medication, is interpreted as being indicative of myocardial change. Aside from a slight rapidity of the pulse, the patient is quite normal, but Doctor Talley advised that he be kept on cardiac rest for some time.

Doctor Pfeiffer remarked that of suppurative pericarditis, Osler said "probably no serious disease is so frequently overlooked by the practitioner". As to its frequency, Cutler states that in an analysis of 3683 necropsy records, at the Boston City Hospital, Locke found 150 instances of acute pericarditis, and of these only twenty-seven or 17 per cent. had been diagnosed clinically. Evidently it is not only the general practitioner who overlooks these cases. Stone, in a study of 300 fatal cases of pneumonia, found pericarditis in seventy-two cases, in forty-four of which the fluid was purulent. Suppurative pericarditis should be considered as a possible complication, especially, in pneumonia, osteomyelitis, or other septic states that present a puzzling and otherwise unexplainable toxæmia. Once the diagnosis is reasonably established there should be no hesitation or delay in resorting to surgical treatment, without which the mortality of reported cases, now in the neighborhood of 130, is over 50 per cent. Many of these cases were late and some died of associated lesions. Certain cases, apparently moribund, recovered by release of the pressure of the exudate upon the heart, the so-called cardiac tamponade, which prevents the venous blood from reaching the chambers of the heart. The operation itself is simple and singularly devoid of inherent complications. It lends itself readily to local anæsthesia. Adequate drainage for an adequate period of time is the prime essential. This has been accomplished successfully through a great variety of approaches: (1) through the sternum; (2) to the right of the sternum; (3) to the left of the sternum, (*a*) by intercostal incision, (*b*) by trap-door incision, (*c*) by excision of one, two or three costal cartilages; and (4) by xiphisternal incision. The method employed in this case was that described by Doctor

Pool at the first joint meeting of this Academy with the New York Surgical Society in 1920, and published in the ANNALS OF SURGERY in April, 1921. This was a slight modification of the method of Délorme and Mignon. It would seem to be of almost universal applicability in its simplicity, adequacy of exposure and dependence of drainage. The methods, materials and even the necessity of irrigation are not entirely settled. A fair number of cases have recovered without employment of any irrigating fluid. In the case here reported, owing to the rapid formation of fibrinous coagulum, it is doubtful if more than the drainage sinus itself was reached by the Dakin's solution employed. But this was an early case and a strong bodily immunity to the previous pneumococcus infection was undoubtedly present. Cases presenting greatly dilated sacs and heavy exudate would be a different problem and irrigation would seem indicated. It has been established that a large variety of mild antiseptic substances may be tolerated as irrigation materials. Their relation to subsequent pericardial adhesions remains to be demonstrated. While very early cases may do well on simple postural drainage, it is probable that the majority will require the assistance of irrigation to carry off the excess of exudate and prevent subsequent pocketing in the lateral and posterior recesses of the pericardium.

DR. JOHN H. JOPSON remarked that he assumed charge of this patient in Doctor Pfeiffer's absence from the city and pursued his policy of masterly inactivity with continuous amazement that a patient as sick as this young man was—with elevated temperature, etc.—should continue to do so well. He was able to sit up in bed, to eat and to read. No factor was present which necessitated interference. The speaker has been interested in the report on certain cases many years later. One case which Doctor Porter reported before the American Surgical Association last year, was a patient who had been operated upon by Doctor Porter's father. He had been an interne at the Massachusetts General Hospital at the time. He was reported as being alive and in good health, this being many years after operation. The prospect for a good functional and organic recovery is excellent. The pictures which Doctor Pfeiffer showed indicate that there was a change in the angle at which the pericardial shadow appeared in its relation to the diaphragm. As the patient progressed to recovery there was a change in this angle and a diminution of the shadow on the opposite side. The speaker has now at the Graduate Hospital a case in which the patient was operated upon seven weeks ago for a mediastinal dermoid of the right chest, associated with bronchiectasis of the lower portion of the right lung, which led to the diagnosis of pulmonary abscess. She progressed toward recovery until recently when she has had dyspnœa, orthopnœa, and rapid pulse. The heart shadow is still large. At the time of operation Doctor Jopson thought that the pericardium might have been injured. It is important to follow such cases in later years. The eventual result is inclined to be satisfactory.

DR. GEORGE P. MULLER said that shortly after Doctor Pool read his paper on this subject, he had a case of suppurative pericarditis with pleural effusion.

The patient was nine years of age, had had influenza and pneumonia and was very ill. He also had an area of osteomyelitis of the lower end of the femur. The patient did not do so well with drainage. The diagnosis of suppurative pericarditis was made and the röntgenogram showed abnormal dilatation of the heart. Doctor Muller operated upon him by the method of Pool and removed one pint of pus from the pericardial sac. A Dakin's tube was introduced and the patient made a good recovery. The pleural cavity was aspirated twice for fluid. He was seen three times in the next year and curettement performed for the osteomyelitis. He was then lost sight of until very recently. He is now sixteen years old. He had no dyspnœa, and no heart murmurs, and Doctor Wolferth reported that there was no essential change in the action of the heart as shown by the electrocardiogram. However, the X-ray of the heart showed an aneurysm of the ventricle. He has no signs of such a condition and it may be due to adhesion of a portion of the heart to the pericardial sac. Whether he actually has a hernia of the heart muscle is uncertain and there is some question as to doing an operation for the purpose of severing such an attachment should it exist.

Dr. A. P. C. Ashhurst, to illustrate the danger of indiscriminate puncture of the pericardium, referred to the following patient who came under his care.

A boy ten years of age with what his family doctor thought was pericarditis. This physician called, as consultant, a specialist in children's diseases. This specialist concurred in the diagnosis and inserted a needle into the region of the heart in four places, but without finding any fluid. The child went into collapse after the punctures. The consultant withdrew the needle from the pericardium and himself from the consultation. The family physician, finding his patient rapidly growing worse, had him transported to the Episcopal Hospital and asked the speaker to see him. He found the little boy apparently moribund, pale, pulseless, and almost apnœic and evidently suffering from compression of the heart by a massive effusion. Under local anæsthesia he inserted a needle just to the left of the ensiform and, on the second puncture, dark blood came in spurts on removal of the obturator. The costal cartilages of the sixth and seventh ribs were then resected and the pericardium exposed; it was about two or three millimetres thick. When it was opened, disorganized blood was ejected with great force in spurts, so that it was thought by Doctor Ashhurst's assistants that he had wounded the right ventricle. The patient improved as the blood continued to flow, the pulse and respiration slowing. The boy awoke as if from the dead and asked if he might have some ice-cream—this was given him on return to the ward. The pericardium was drained by a rubber catheter. Almost two litres of old blood were evacuated from the pericardial sac. The child failed to recuperate, however, and died thirty hours after operation. After death, exploration of the wound showed the heart contracted in systole, and a little bloody serum in the pericardium. Evidently the consulting specialist had punctured the heart and it continued to bleed into the pericardium until the outside pressure sealed the opening into the heart.

PERFORATION OF PEPTIC ULCER

Dr. Henry P. Brown, Jr., read a paper with the above title for which see page 209.

Dr. Charles F. Mitchell said that his personal experience was that fifteen or twenty years ago there were more perforations than we have today. Patients complaining of indigestion come earlier to treatment. Formerly at

the Pennsylvania Hospital, cases in which a positive diagnosis could not be made were recorded as cases of general peritonitis, but the speaker thinks many of these were perforations into the lesser peritoneal cavity. The speaker took exception to Doctor Brown's remarks on anæsthesia; he still prefers ether in these cases to nitrous oxide and oxygen. It gives greater relaxation and in his experience has not been followed by post-operative pneumonia any oftener than after nitrous oxide or oxygen anæsthesia. The operative procedure depends upon the condition of the patient and the judgment of the surgeon; each case should be a rule unto itself. Doctor Mitchell has never done a resection nor a posterior gastro-enterostomy in a case of perforated ulcer. He believes that these cases should all be drained and a wick of gauze put in a suprapubic stab wound. He had yet to regret putting a drain in anybody.

Dr. George P. Muller remarked that Doctor Mitchell stated that he has never yet regretted the putting in of a pelvic drain. In ten years the speaker has not used a pelvic drain and has only had cause to regret this once. That patient had to be operated upon three months later for lower abdominal symptoms, at which time a half pint of mucoid material was removed, after which he recovered. Another case of perforated ulcer which was cauterized and sutured and a gastro-enterostomy done, is now suffering from hæmorrhage, evidently with recurrence of the ulcer. Three days ago he operated upon a patient with a perforated duodenal ulcer. This man was familiar with his condition and as soon as he felt the symptoms at once called a taxi and came directly to the hospital. He had had his office telephone his doctor who met him at the hospital and he was operated upon in less than two hours from the onset of the pain. To do a subtotal gastrectomy in perforated duodenal ulcer would be foolish, but the speaker tries to do a gastro-enterostomy in every case. In the little over half of the cases in which it was not done, the patients have come back with trouble and it has had to be done in the end. Some men believe that only the patients who are not very ill should have gastro-enterostomy. Doctor Muller thinks the ones who are sicker seems to do better with gastro-enterostomy and at once get relief from the pounding against the duodenum and thereby have a better chance for recovery.

Dr. Hubley R. Owen recalled to Doctor Muller the case of a policeman upon whom operation was performed three-quarters of an hour after perforation, which happened while he was in Doctor Owen's office. The man was taken to St. Agnes Hospital and Doctor Muller operated upon him at once. Two weeks ago a second case of perforation occurred while the man was in the office and he was operated upon within a half hour. This year there have been seven cases of perforated peptic ulcer among the policemen and firemen. The one death occurred in a case in which the ulcer was destroyed by cautery. One case perforated during the course of a suppurative appendicitis and general peritonitis. This patient recovered and is doing traffic duty.

Dr. Edward J. Klopp recalled the case of a man operated upon two years

ago for carcinoma of the tongue and while being treated for this, had a perforated ulcer. A gastro-enterostomy was performed and he recovered. He was seventy years of age. As to the question of drainage, last year, Doctor Gibbon had a patient at the Jefferson Hospital who had been operated upon eighteen years before with a diagnosis of bacterial peritonitis. There was a great deal of pus between the diaphragm and the liver and a drain was placed beneath the liver and also one beneath the diaphragm. The patient died thirty-six hours later and the post-mortem showed a large necrotic area in the diaphragm. About the same time the speaker operated upon a man, fifty years of age, and for the same reason placed a drain beneath the diaphragm. He developed empyema and died from a perforation of the diaphragm, approximately two inches in diameter. Doctor Klopp said that he will never again place a drain beneath the diaphragm following an operation for perforation. He agreed with Doctor Muller that the post-operative results are better when gastro-enterostomy is done, provided, of course, the case will permit of such procedure.

Dr. Emory G. Alexander said that the great majority of medical students seem to have been taught that one gets shock in perforated duodenal ulcer. He had never seen it except late in the case, when peritonitis has occurred. The speaker did not quite agree with Doctor Mitchell that there are not as many perforations recently as there were years ago. He has three cases under his care at the present time. In 1914 or 1915 he reported a series of twenty-five or thirty cases with discussion as to whether or not gastro-enterostomy should be done. Gibson, of New York, had written on that subject. These cases reported to Doctor Alexander's office and were questioned without looking up the histories to see whether or not gastro-enterostomy had been performed. From the end results he was unable to determine which patients had had gastro-enterostomy and which had not. The speaker feels that if the patient has a more or less acute perforation with no induration a gastro-enterostomy need not be performed. Gastro-enterostomy is indicated, however, when the induration is too great to allow satisfactory closure of the ulcer. It is unwise to advocate any one procedure when so many varieties of treatment are possible. He had never seen a recurrence in a perforated duodenal ulcer treated by simple closure, but had seen two cases recur after gastro-enterostomy; one with perforation of a gastrojejunal ulcer and the other with perforation of a jejunal ulcer. Cultures from the ulcer itself, in the upper and lower peritoneal cavity, are usually negative. The speaker believes that it is safer to drain than not. The drainage does no harm and can usually be taken out in a few days.

Dr. Charles F. Nassau said that the various opinions as to operative procedure represent a difference in surgical judgment. Whether this judgment is based upon logic or upon the whim of the individual it is hard to say. As to the type of anæsthesia: many use local anæsthesia because they believe it to be a safeguard against pneumonia, yet we must admit that there are a certain definite number of pneumonias following the use of local anæsthesia,

regardless of the type of operation—even outside of the abdominal cavity. Everyone has probably seen a statement made by von Haberer's assistant that, although he operates under splanchnic anæsthesia, just as many pneumonias develop as when he used a general anæsthetic. Of course, there are other reasons for using local anæsthesia. In an elective operation there is no doubt that the patient enjoys an easier convalescence. The speaker agrees with Doctor Alexander that the wisest thing to do in perforation of peptic ulcer is a simple closure of the ulcer. Years ago he did gastro-enterostomy for this condition and it is not a much more difficult procedure, nor does it take a much longer time to perform. However, the length of operation is not the main consideration; there is the matter of extra tissue damage and whether the procedure is necessary. Gastro-enterostomy can always be done later if the post-operative condition shows that something else is needed. This is Doctor Nassau's feeling at the present time, and unless something extraordinary developed and he thought the lumen of the duodenum was in danger of occlusion he would not do gastro-enterostomy.

The question of drainage is interesting. With increasing experience all surgeons use less and less drainage in the so-called "bad" appendix cases. Experience has taught us much about the closure of bad wounds within a few hours, after complete disinfection. The speaker believes that if in perforated duodenal ulcer operation is done within six or eight hours after perforation, drainage is never necessary unless there are some conditions that make it clearly advisable. However, care should be used in teaching this theory to students. In making a decision between gastro-enterostomy and pyloroplasty, a pyloroplasty should not be done in an acute condition. To perform it or a Kocher's gastro-duodenostomy is infinitely more difficult and dangerous than to do gastro-enterostomy.

Dr. Irvine M. Boykin said in regards to the closure of abdominal wounds that the catastrophe of having them break open can be avoided by making the incision in more than one plane. In operations on the stomach and epigastrium, a right paramedian incision, whereby the rectus muscle is lifted and retracted outward and the posterior sheath opened beneath, gives an incision in three planes. In the closure of wounds the use of the splint suture of silkworm gut 1 centimetre or 1.5 centimetre apart in support of the catgut sutures is an excellent preventive. Drainage in perforated ulcer cases, at the site of perforation, is seldom necessary. Seepage from the upper abdomen is collected in the pelvis and a drain in the pelvis should be sufficient. Posterior gastro-enterostomy *per se* does not cure ulcers. The speaker thinks that posterior gastro-enterostomy should not be done unless a closure of the ulcer cannot be effected.

Dr. A. P. C. Ashhurst said that Doctor Alexander has raised the question as to the existence of shock in any case of gastric or duodenal perforation. Hence it is pertinent to ask the question, "What are the symptoms of shock?" The symptoms of shock are torpidity of mind, paleness or faint cyanosis of the body, and rapid pulse. The speaker once talked to Dr. John

B. Deaver about the occurrence of symptoms of shock after perforation. Doctor Deaver had just read Moynihan's paper in which he asserted there was no shock in such cases. Doctor Ashhurst wrote to Doctor Deaver outlining the symptoms as he had seen them in a case of perforation: the patient was torpid in mind; pale—almost cyanotic—in body; and indifferent to his surroundings. But his pulse was slow. To this Doctor Deaver replied: "I would say that this was shock." The slowness of the pulse is the only feature which is unusual in typical cases of shock, and is probably due to absorption of duodenal contents from the peritoneal cavity. Bradycardia is not an infrequent symptom in biliary obstruction. It is, however, quite true that shock is very unusual in cases of gastric or duodenal perforation.

No one has mentioned what to do with perforations that one cannot suture. A piece of omentum can be sutured over rather insecure sutures, and usually it will keep the perforation closed. But this plan will not succeed unless some kind of suturing is used. In two patients the perforation occurred in the middle of an indurated sieve-like area where no suture would hold and the speaker was forced to tampon the area. He thought the patients would leak gastric juice and die but both of them recovered.

Regarding gastro-enterostomy the speaker is eclectic. He thinks that it should be done whenever it is justified. If he thinks it will kill the patient he does not do it. No one but the surgeon operating can decide this. Two patients, in whom the perforated pyloric ulcer was closed without gastro-enterostomy primarily, have returned complaining of symptoms of indigestion for which a secondary gastro-enterostomy was done.

Dr. William J. Ryan said that in two of his cases of perforated ulcer the wounds broke open but smears of them failed to disclose the presence of pathologic bacteria at any time, nor was any gross pus present. He, therefore, concluded that leakage of the gastric contents occurred through the suture lines, causing the wounds to become digested. The wounds were splinted with silkworm-gut sutures about one-half inch apart.

Dr. Henry P. Brown, Jr., added that all three types of ulcers were included. Gas oxygen anæsthesia was used. In 1927 the records show ten cases of perforation and fifty-four cases with other diagnoses. In 1924 the records showed nine cases of perforation and forty-six other diagnoses.

BRIEF COMMUNICATION

THE HARPANAHALLI BEZOAR

In addition to the "Bezoars" mentioned in the October, 1928, issue of the Annals of Surgery I may add one more kind of Bezoar to Doctor Maes' classification. This kind of Bezoar is caused by a pill said to be made out of the blood of a species of chameleon in combination with certain other indigenous East Indian drugs. This was used by certain Brahmin widows of the Western Taluks of the Bellary District (Madras Presidency) to cause the slow decline and death of strangers who happened to share their table. There is a superstition among them that this mode of doing away with young and energetic men—mostly executive officials—paves the way for their salvation. Whatever the object might be, the bolus of food in which it is administered forms the Bezoar, with the minute pill as the nucleus, and the food around never gets digested. This is proved by the fact that even after six months the vomited Bezoar, if it fortunately occurs, contains the very food in which it was administered originally. This kind of Bezoar acts in the same manner as all the others and causes symptoms akin to them.

The pain and uneasiness in the epigastrium begins about a fortnight after the administration. Intense gastritis and active dyspepsia set in. There is some accompanying fever also, and the patient ultimately dies of slow inanition in from three to six months. Though this Bezoar is comparatively small, it does not come out in the vomit, nor does it pass the pyloric sphincter. The horrible practice has become practically extinct; although some sporadic cases do still occur here and there.

The above history was gotten from the few patients who have survived the ordeal with the help of prompt and proper treatment. This treatment consists in giving a green shrub internally, which is with difficulty found in those parts; and this acts by bringing the Bezoar along with the vomit or allowing it to pass through the pylorus and be discharged in the fæces. But it is indeed fortunate for the stranger that this is almost a bygone practice at present.

This pill is said to have been originated at Harpanahalli, the intellectual centre of that district, and goes by the same name; and hence we may also name this condition as "Harpanahalli Bezoar."

S. V. Nathan, M.D.,
Madras, India.

MEMOIRS

FREDERIC KAMMERER

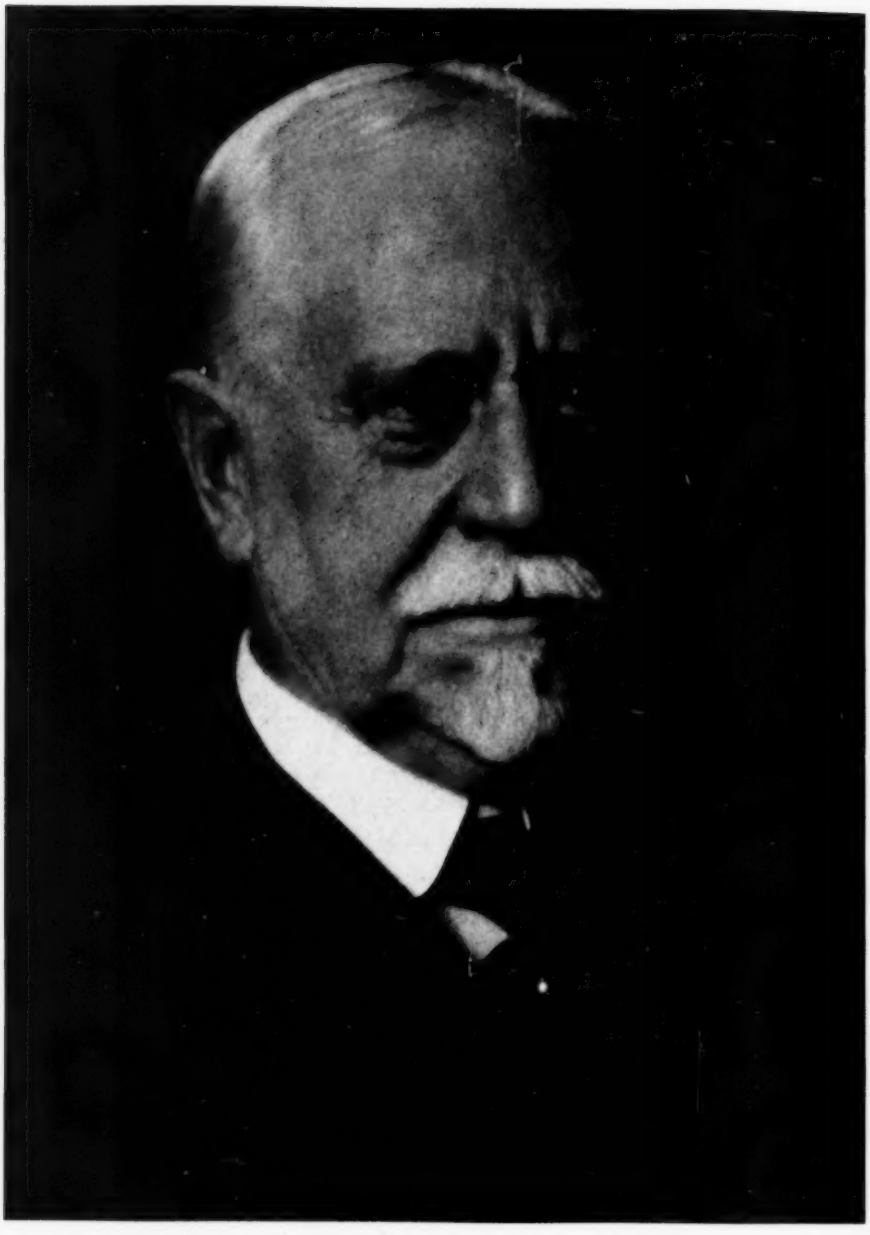
1856–1928

On September 26, 1928, Frederic Kammerer died at Merano, Italy, in his seventy-third year. For several years he had been suffering from a rather marked arterial hypertension, and he finally succumbed to a cerebral hæmorrhage. Until his fatal attack he had been mentally alert as ever, and he was fortunately spared the period of invalidism and helplessness which he so dreaded.

Frederic Kammerer was born in New York City February 4, 1856. His father, Dr. Joseph Kammerer, was of Swiss birth, being brought to this country at the age of four. Educated in Europe, he returned to New York City, taking up the practice of medicine, specializing largely in gynecology and obstetrics. He was one of the founders of the present Lenox Hill Hospital, then known as the German Hospital, and at the time of his death in 1875 he was professor of obstetrics at the Medical School of New York University. Doctor Kammerer's mother, Léonie von Weisseneck, was descended from an Austrian family of some distinction which had settled in Germany.

Doctor Kammerer's elementary education was obtained in private schools in New York City, and later in the Polytechnic Institute at Karlsruhe, Baden, Germany, from 1872 to 1875, when, on the death of his father, he returned to America. Within a year he left again for Europe, to begin the study of medicine at Freiburg. He received his doctor's degree in Freiburg in 1880. For one year, 1878 to 1879, he was an assistant in the Anatomical Institute of Professor Robert Wiedersheim, at Freiburg, and after graduation, for four years, from 1881 to 1885, he was assistant at the Surgical University Clinic in Freiburg, first under Professor Hermann Maas, and later under Professor Paul Kraske. For half a year in 1885 he was an assistant at the Gynecological Clinic of Professor Carl Schroeder, in Berlin, and for nearly a year, 1885 to 1886, he worked in the laboratory and assisted in the Medical Clinic of Professor Ludwig Lichtheim, at Berne, Switzerland.

With this very thorough general and special training, Frederic Kammerer came back to New York City in November, 1886, to take up the practice of surgery. In 1889 he was appointed Attending Surgeon to the German Hospital of New York City, later the Lenox Hill Hospital. This position he held until he retired on reaching the age limit of sixty-five years in 1921, when he was made Consulting Surgeon to this institution. In 1890 he received the appointment of Attending Surgeon to St. Francis' Hospital, of New York City. He held this position until 1911, when he became Consulting Surgeon



to this hospital. From 1900 on he held the position of Consulting Surgeon to St. Mary's Hospital, Hoboken, New Jersey. He was professor of Clinical Surgery at Cornell University Medical College from its foundation in 1898 to 1909, and he held a similar position at the College of Physicians and Surgeons, Columbia University, from 1909 to 1921.

In November, 1915, he headed a hospital unit sent to Germany by the American Physicians' Expedition Committee. This unit took charge of a military reserve lazaret at Deutsch-Eylau, West Prussia. Doctor Kammerer remained there until May, 1916. Though not at all in sympathy with Germany in the World War, it was quite in line with his character that he felt impelled to offer his services to the country where he had obtained his medical training, in grateful part-payment for what she had given to him.

In April, 1917, he accepted a commission as Major in the Medical Corps of the United States Army. He organized and became the Director and Chief of the Surgical Service of Red Cross Base Hospital No. 16, recruited from the German Hospital of New York City. This unit was later assigned to United States Army General Hospital No. 12, stationed at Biltmore, North Carolina. Doctor Kammerer went on active duty in March, 1918, and remained in the service as Surgical Chief of this hospital until after the armistice, being honorably discharged December 3, 1918.

In 1907 he was married to Miss Ida Knapp, the daughter of the late Dr. Herman Knapp. Mrs. Kammerer survives the doctor. They had no children. Doctor Kammerer retired from practice in November, 1921. His permanent address thereafter was Berne, Switzerland.

Doctor Kammerer had been a Fellow of the American Surgical Association since 1899. He was a member of the New York Surgical Society and its president from 1913 to 1915. He was also a member of the International Surgical Association, the American Gastro-enterological Association and the Deutsche Gesellschaft für Chirurgie, and a Fellow of the American College of Surgeons, and of the New York Academy of Medicine.

Though not a prolific writer, Doctor Kammerer made a number of important contributions to the literature. The one upon which he always looked with the greatest pride was on gonorrhœal arthritis, published in 1884, while he was an assistant at Kraske's Clinic in Freiburg. In this "Arbeit" he was the first to show the presence of the gonococcus in the joint, and the first, therefore, to prove it to be the cause of the articular inflammation. Perhaps his best-known contribution to surgical technic was made in 1897—the description of the so-called "right rectus" incision for appendicitis, known in America as the "Kammerer incision." In 1899 he reported a successful ligation of the first portion of the subclavian artery for aneurysm. His patient lived for four weeks. He was expert in thyroid surgery, and was among the first to demonstrate the technic of thyroidectomy in America.

Doctor Kammerer's surgical contributions were by no means confined to his published papers. He disseminated his views and the fruits of his rich experience by personal contacts and particularly through his society discus-

sions—especially in the American Surgical Association and in the New York Surgical Society. With a clear, logical mind and a wide, intelligent vision, he contributed much valuable thought on these occasions. It can be truly said that he was one of the pioneers of our modern American surgery.

At the time Doctor Kammerer returned to his native land, the aseptic era was just dawning. By teaching and example he helped to spread the doctrines in this country on which our subsequent surgical development rested.

There was a strong humanitarian side to his character which manifested itself in his tender devotion to his patients, whose welfare was his primary concern. To his assistants he was a most particular and exacting taskmaster, though he was never unkindly, and invariably just and fair. He had a sense of honor and a purity and nobility of character that are rarely met with. He had great capacity to charm and attract people, but was rather reserved and sensitive. He much preferred the companionship of a few intimates, who, recognizing his sterling qualities and his really affectionate disposition, loved him dearly.

Personally he was above all a courtly, cultured and scholarly gentleman of the old school. Of a very studious turn, he read much, both in his special field and in general literature, even during his latter years, and after he had retired from active work. Aside from his profession he had numerous and varied interests. He was an ardent lover of nature, and had traveled and hunted in many of the wilder parts of this country and in Europe. He enjoyed visiting his friends and colleagues in the various medical centres of the Old World, and traveling after his retirement and settlement in Europe became one of his main hobbies. He himself was a collector of etchings and engravings. He was passionately fond of music, of which his knowledge was profound and his appreciation very keen. He was an excellent performer on the 'cello. He was an active and enthusiastic member of the Charaka Club, that famous group of leaders in medicine who gave some of their thought and attention to the literary, historical and cultural aspects of their calling.

This summarizes the life and work of a great and modest soul that has passed on. He was a man of great versatility and unimpeachable character, a gifted, high-minded and universally-respected surgeon. His influence will be felt for many years to come and his work will endure. To those who were privileged to know him intimately, his death brings a sense of irreparable personal loss.

DeWitt Stetten

HOWARD A. LOTHROP

1864–1928

Dr. Howard A. Lothrop, who died June 4, 1928, was born in Sharon, Massachusetts, December 31, 1864, the son of Horace A. and Sarah Gorham (Swain) Lothrop. As a boy and student he was greatly interested in natural history, especially ornithology. He made a wonderful collection of birds, which he prepared and mounted himself with remarkable skill and success. The deftness of hand developed in this way in youth contributed not a little to the skill which he afterward displayed as a surgeon. He attended the Boston Latin School, entered Harvard College and graduated *magna cum laude* in the Class of 1887. In 1891 he graduated from the Harvard Medical School, where he led his class, with the degrees of M.D. and A.M. He studied in Vienna for two years; then served as House Officer at the Massachusetts General Hospital. Entering practice in Boston, he soon received an appointment as Surgeon to Out-patients at the Boston City Hospital, where he did excellent work, rising through the grades to Surgeon-in-chief. His surgical work was skilful, conservative and successful. At one time he did some brilliant work on the ligation of arteries for aneurysm. He was one of the early contributors to our knowledge of epigastric hernia. He was Instructor in Surgery in the Harvard Medical School from 1903 to 1912, Assistant Professor of Surgery from 1912 to 1922, and Acting Professor of Surgery, 1922–1923. He devoted a great deal of care to the preparation of his lectures and clinics, never missed his appointments with the students, and took special pains to give adequate instruction in surgical technic. For many years he was a contributing member to the meetings of the American Surgical Association.

Howard A. Lothrop, M.D.

Doctor Lothrop made an enviable reputation for himself as an expert witness in accident cases. He was fair, conservative and accurate in his statements, and his counsel was often sought by accident boards and corporations in the disposition of such cases. He was very fond of music, was a skilful musician, and had a fine tenor voice, which he cultivated until he became a welcome singer at evening entertainments. He sang for many years in the Harvard Alumni Chorus. He took great interest in the "Doctors", a social club formed around the members of the Class of 1891 in the Medical School, of which he was a member. He never married and lived with his mother, who survives him, as do his two brothers, Dr. Oliver A. Lothrop, of Boston,

and John Howland Lothrop, of Portland, Oregon, and three sisters. He was a hardworking, faithful and skilful surgeon, and, as a result of his skill, gained a large practice and many enthusiastic admirers. He had retired from the staff of the Boston City Hospital in January, 1927, but continued to attend to his large private practice. He was one of the youngest-looking men among his contemporaries, and although never athletic, except in his college days, kept in fine bodily condition.

His death was caused by septicæmia, which resulted from an infection of his thumb, pricked by a safety-pin two weeks before. This infection proved fatal in spite of all efforts, including amputation of the arm. He bore his last illness with amazing fortitude and faced the amputation with unshrinking courage.

F. B. LUND

EDITORIAL ADDRESS

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